United States Department of Agriculture

Agricultural Research Service

Agricultural Research Results ARR-NE-13

September 1981

Aircraft Remote Sensing of Soil Moisture and Hydrologic Parameters, Taylor Creek, Fla., and Little River, Ga., 1979 Data Report

ABSTRACT

Jackson, T. J., T. J. Schmugge, L. H. Allen, Jr., P. O'Neill, R. Slack, J. Wang, and E. T. Engman. 1981. Aircraft remote sensing of soil moisture and hydrologic parameters, Taylor Creek, Fla., and Little River, Ga., 1979 data report. U.S. Department of Agriculture, Agricultural Research Results 13, 36 pp.

Experiments were conducted to evaluate aircraft remote sensing techniques for hydrology in a wide range of physiographic and climatic regions using several sensor platforms. The data were collected in late 1978 and during 1979 in two humid areas--Taylor Creek, Fla., and Little River, Ga. This report includes soil moisture measurements, climatic observations, and the remote sensing data collected using thermal infrared, passive microwave, and active microwave systems.

KEYWORDS: Hydrology, microwave, remote sensing, soil moisture.

Agricultural Research Service

U.S. DEPARTMENT OF AGRICULTURE

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ACKNOWLEDGMENTS

This study would not have been possible without the assistance of approximately 40 people who obtained and processed the data. Participants were from the Southeast Watershed Research Laboratories, Agricultural Research Service, U.S. Department of Agriculture, at Athens and Tifton, Ga., the Agronomy Department of the University of Georgia, Athens, and the Food and Agricultural Institute of the University of Florida, Gainesville.

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A free copy of this publication is available from the Hydrology Laboratory, Beltsville Agricultural Research Center-West, Beltsville, Md. 20705.

Agricultural Research Service, Agricultural Research Results, Northeastern Series, No. 13, September 1981

Published by Northeastern Region, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Md. 20705

AIRCRAFT REMOTE SENSING OF SOIL MOISTURE AND HYDROLOGIC PARAMETERS, TAYLOR CREEK, FLA., AND LITTLE RIVER, GA., 1979 DATA REPORT

by T. J. Jackson, T. J. Schmugge, L. H. Allen, Jr., P. O'Neill, R. Slack, J. Wang, and E. T. Engman[1/]

Cooperative investigations were conducted during 1978 and 1979 by the National Aeronautics and Space Administration (NASA) and the U.S. Department of Agriculture (USDA) as part of a project to evaluate remote sensing in hydrologic studies with primary emphasis on soil moisture measurements. Participants in the study were from the NASA Goddard Space Flight Center, the USDA Agricultural Research Service (ARS) Hydrology Laboratory, the Georgia Coastal Plain Experiment Station, and the University of Florida.

Experiments were planned to evaluate aircraft remote sensing techniques in a wide range of physiographic and climatic areas using several sensor systems. Jackson et al. (1980)[2/] reported the results obtained from two semiarid areas. In this report, experiments were conducted in two humid areas--Taylor Creek, Fla., and Little River, Ga.

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2/ The underlined year in parentheses after the authors' names refers to Literature Cited, p. 33.

EXPERIMENTAL DESIGN

GENERAL

Experiments were designed to collect remote sensing data concurrent with ground observations of hydrologically significant parameters and phenomena, primarily soil moisture within several surface layers. An important feature of the experiments was that the observations were made on intensively monitored watersheds.

GROUND SAMPLING PROCEDURES

Taylor Creek, Fla., Test Site

The sampling locations in Florida were all in or west of the Taylor Creek Experimental Watershed, which is monitored by the USDA-ARS. They are in Okeechobee County just north of Lake Okeechobee in the Atlantic Coastal Flatwoods subprovince of the Coastal Plain physiographic region. Figure 1 is a map of this area.

Watershed W-2 has an area of 270 km^2 and is relatively flat with slopes between 0 and 2 percent. Soils are mostly fine sands and land cover is pasture, range, and forest. The area is characterized by many depressions and swampy areas.

Two flightlines, referred to as F2 and F3, were flown on November 30, 1978, and May 2, May 22, and June 13, 1979. Their general locations are shown in figure 1. Sampling sites are indicated in figure 2, which is a high-altitude photograph obtained in May 1978 and, therefore, some conditions may be different.

Flightline 2 covered mostly citrus grove sites. Figure 3 illustrates the layout of the groves. A smaller scale photo of sites F204 and F205, obtained during this study, is presented in figure 4. This illustrates the typical citrus grove with tree rows and water distribution furrows in between.

Flightline 3 traversed mostly pasture and swampy areas. The darker spots in figure 2 are wet areas caused by shallow water table conditions.

Soil type and land cover at each site are listed in table 1. Drainage and hydrologic characteristics among the sites were highly variable. Sites F201 through F205, F305, F306, F309, and F312 were all on type D soils, which are generally poorly drained (U.S. Soil Conservation Service, 1974). All the other sites were on type B soils, which have generally good hydrologic properties. Soil property data available in other reports for several of the soils in table 1 are summarized in the Appendix.

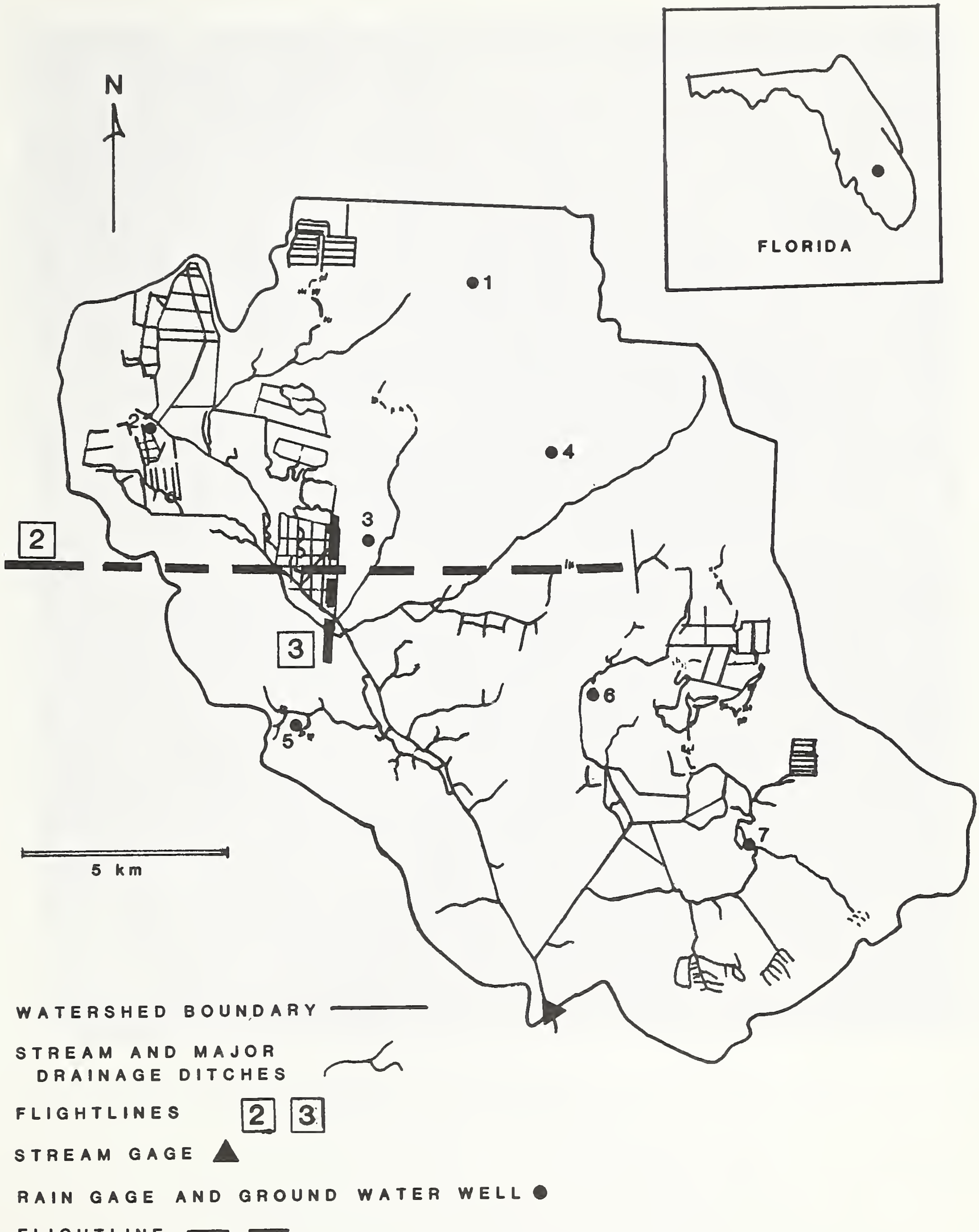

Figure 1.--Taylor Creek watershed, Fla.

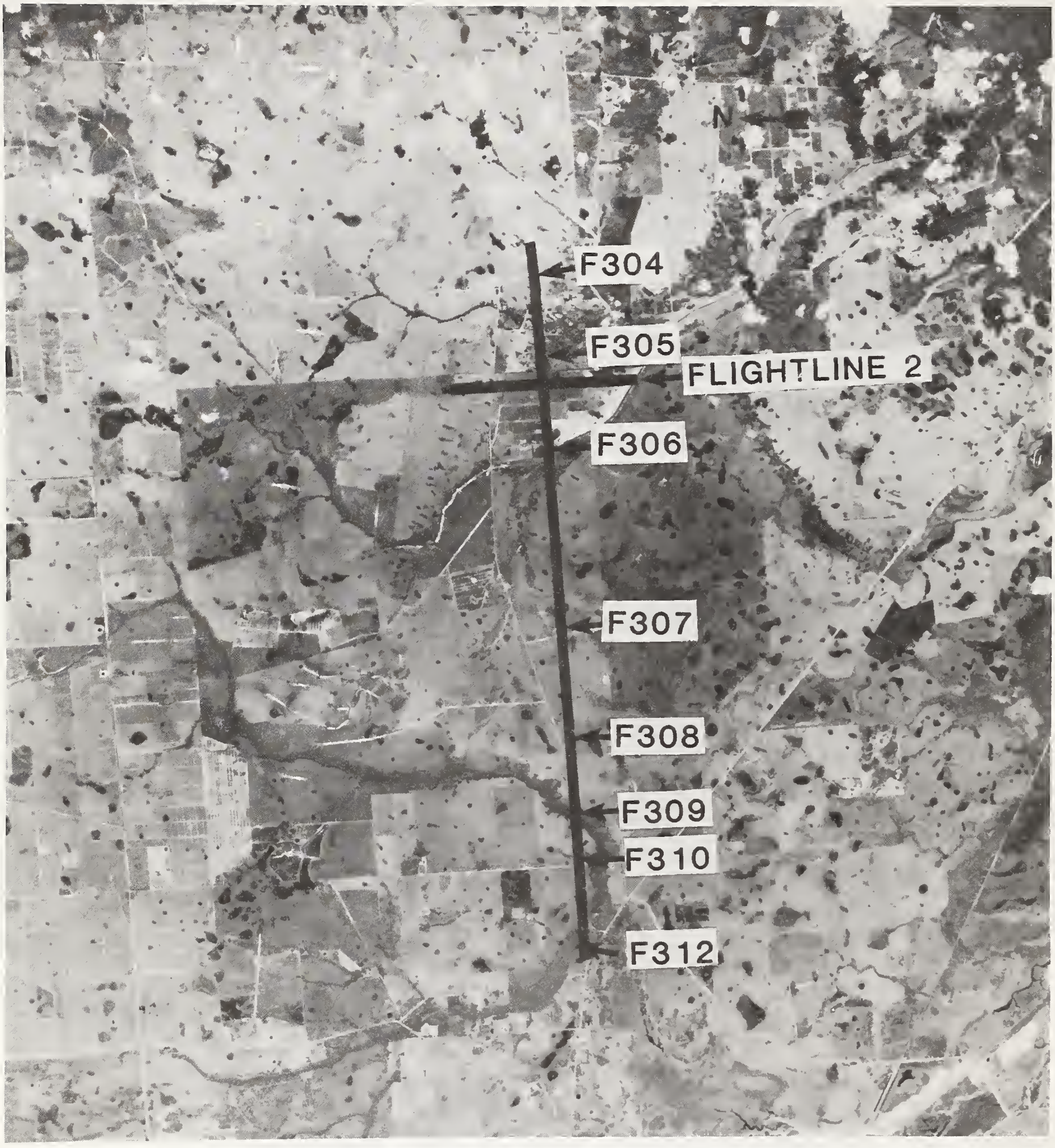

Figure 2.--Florida sampling sites. Black and white rendition of color infrared photo at 1:125,000 scale.

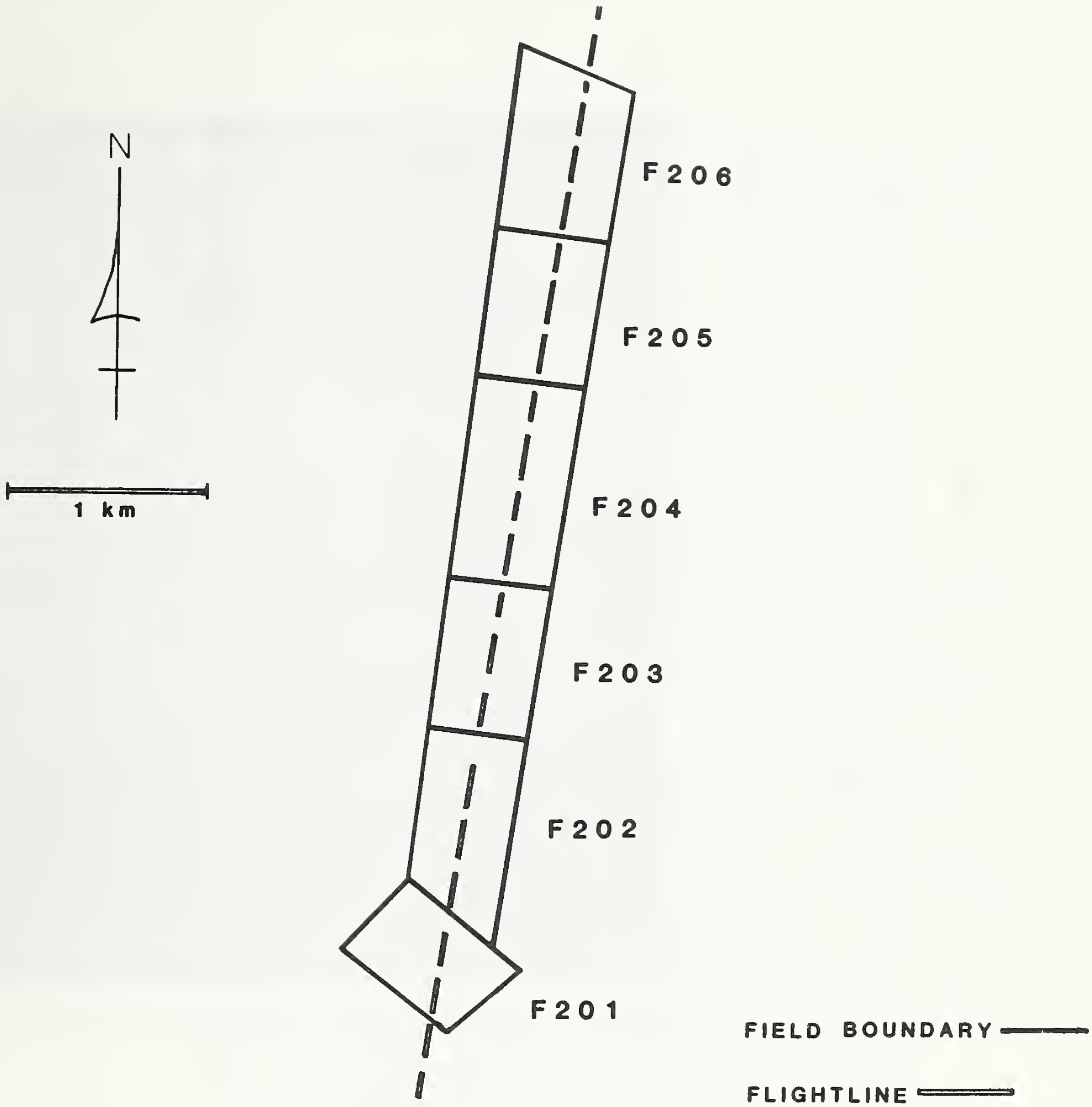

Figure 3.--Flightline 2, Taylor Creek, Fla.

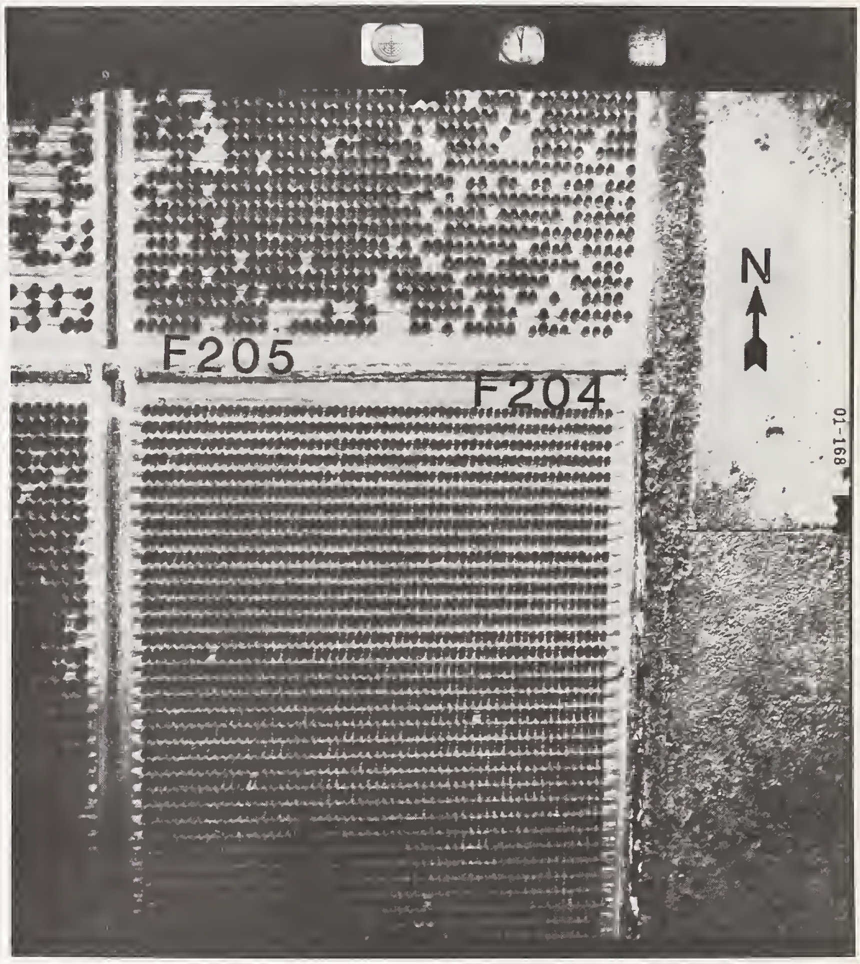

Figure 4.--Florida citrus grove sites F204 and F205 at 1:20,000 scale.

Table 1.--Soil type and land cover by site, Taylor Creek, Fla.

Site	Soil type	Land cover
F201	Chobee fine sandy loam	Citrus grove.
F202	do.	Do.
F203	do.	Do.
F204	do.	Do.
F205	Bradenton fine sand	Do.
F206	Immokalee fine sand	Do.
F304	do.	Native pasture, 10-15 cm.
F305	Wabasso fine sand	Native pasture, sparse trees.
F306	Bradenton fine sand	Woodland, palms and deciduous.
F307	Immokalee fine sand	Improved pasture, 2.5-15 cm dense.
F308	Myakka fine sand	Improved pasture, 15 cm dense.
F309	Placid, Pamlico, and Delray soils, ponded.	Dense cypress, water.
F310	Myakka fine sand	Improved pasture, 2.5-10 cm, close grazed.
F312	Placid, Pamlico, and Delray soils, ponded.	Mixed vegetation, water.

Taylor Creek has a very humid climate. Daily temperatures average about 296 K (23° C) and vary between 291 and 305 K (18° and 32°) in the summer. Average annual rainfall is about 120 cm, and three-fourths occurs between May and October. Annual pan evaporation averages 152 cm and annual runoff about 33 cm. Rain-gage locations are shown in figure 1. Climatological data during the experiments are in table 2.

Table 2.--Taylor Creek, Fla., climatological data, 1978 and 1979

Date	Pan evapo-ration 1/	Daily temperature		Rainfall at rain gage						
		Max.	Min.	1	2	3	4	5	6	7
	Cm	---Deg. K	---	-------------------			Cm	-------------------		
1978										
Nov. 1----	0.122	300	292	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2----	.122	300	286	.00	.00	.00	.00	.00	.00	.00
3----	.152	297	286	.00	.00	.00	.00	.00	.00	.00
4----	.152	298	284	.00	.00	.00	.00	.00	.00	.00
5----	.244	300	281	.00	.00	.00	.00	.00	.00	.00
6----	.244	300	286	.00	.00	.00	.00	.00	.00	.00
7----	.00	298	289	3.00	4.98	1.80	2.72	3.73	2.03	1.60
8----	.00	300	294	.05	.05	.13	.13	.05	.20	.15
9----	.00	299	292	.00	.00	.00	.00	.00	.00	.00
10----	.091	301	294	.00	.00	.00	.00	.00	.00	.00
11----	.244	302	292	.00	.00	.00	.00	.00	.00	.00
12----	.396	301	290	.00	.00	.00	.00	.00	.00	.00
13----	.152	302	289	.00	.00	.00	.00	.00	.00	.00
14----	.152	299	292	.46	.25	.05	.08	.08	.10	.05
15----	.213	302	291	.00	.00	.00	.00	.00	.00	.03
16----	.213	301	292	.00	.00	.00	.00	.00	.00	.00
17----	.213	302	291	.00	.00	.00	.00	.00	.00	.00
18----	.152	302	288	.00	.00	.00	.00	.00	.00	.00
19----	.152	301	290	.00	.00	.00	.00	.00	.00	.00
20----	.00	299	292	.75	1.14	.63	.53	.33	.36	.15
21----	.00	300	292	.18	.13	.00	.02	.02	.00	.00
22----	.122	302	292	.00	.00	.00	.00	.00	.00	.00
23----	.152	302	289	.00	.00	.00	.00	.00	.00	.00
24----	.152	300	289	.00	.00	.00	.00	.00	.00	.00
25----	.122	299	286	.00	.00	.00	.00	.00	.00	.00
26----	.244	300	285	.00	.00	.00	.00	.00	.00	.00
27----	.304	300	288	.00	.00	.00	.00	.00	.00	.00
28----	.244	303	288	.00	.00	.00	.00	.00	.00	.00
29----	.213	303	292	.08	.18	.00	.00	.00	.00	.00
30----	.213	303	293	.02	.02	.00	.00	.00	.00	.00
1979										
Apr. 24----	.10	296	294	3.02	2.72	2.51	3.00	1.93	2.16	2.01
25----	.18	299	291	1.75	2.49	1.73	1.60	1.27	1.40	.56
26----	.46	301	290	.28	.64	.30	.23	.20	.20	.86
27----	.64	302	293	.00	.00	.00	.00	.00	.00	.00
28----	.76	303	288	.00	.00	.00	.00	.00	.00	.00
29----	.51	303	293	.00	.00	.00	.00	.00	.00	.00
30----	.13	299	294	1.83	1.83	1.55	1.42	1.17	1.19	1.57

Table 2.--Taylor Creek, Fla., climatological data, 1978 and 1979--Continued

Date	Pan evaporation 1/	Daily temperature		Rainfall at rain gage						
		Max.	Min.	1	2	3	4	5	6	7
	Cm	---Deg. K---		-------------------Cm-------------------						
1979										
May 1----	0.18	298	292	0.20	0.15	0.18	0.15	0.20	0.13	0.15
2----	.36	301	292	.00	.03	.00	.03	.00	.00	.00
3----	.69	301	292	.00	.00	.00	.00	.00	.00	.00
4----	.69	304	295	.00	.00	.00	.00	.00	.00	.00
5----	.61	305	293	.03	.00	.04	.01	.04	.00	.00
6----	.46	304	295	.02	.01	.01	.01	.01	.01	.02
7----	.15	298	295	.85	.81	1.15	.80	1.06	.76	.87
8----	.18	301	295	1.06	.50	1.77	2.74	2.00	3.05	2.18
9----	.30	302	294	2.12	1.16	1.01	.83	1.01	.74	1.06
10----	.30	302	295	2.11	.66	.83	1.67	.03	.20	.17
11----	.64	303	294	.00	.00	.00	.00	.00	.00	.04
12----	.30	302	294	.00	.00	.00	.00	.00	.00	.00
13----	.41	302	295	.00	.04	.11	.00	.50	.00	.00
14----	.18	301	294	1.45	.88	2.42	1.49	1.86	1.77	.86
15----	.33	300	294	.00	.00	.03	.00	.09	.08	.07
16----	.53	301	294	.00	.00	.00	.00	.00	.00	.00
17----	.20	299	291	.43	.37	.12	.23	.37	.01	.01
18----	.56	299	287	.00	.00	.00	.00	.00	.00	.00
19----	.64	299	287	.00	.00	.00	.00	.00	.00	.00
20----	.43	301	291	.00	.00	.00	.00	.00	.00	.00
21----	.50	303	291	.00	.00	.00	.00	.00	.00	.00
22----	.69	303	293	.00	.00	.00	.00	.00	.00	.00
23----	.46	303	296	.39	.07	.09	.11	.09	1.31	1.31
24----	.15	302	294	1.52	1.17	.99	1.26	1.40	1.58	1.43
25----	.56	302	287	.00	.00	.00	.01	.02	.02	.02
26----	.79	302	286	.00	.00	.00	.00	.00	.00	.00
27----	.61	302	290	.02	.19	.01	.00	.00	.00	.01
28----	.46	305	294	.26	.48	.36	.05	.20	.00	.00
29----	.18	304	295	.01	.01	.09	.01	.25	.00	.00
30----	.33	303	296	.52	.07	.31	.70	.31	1.56	.15
31----	.76	304	296	.00	.00	.00	.00	.00	.00	.00
June 1----	.64	304	295	.00	.00	.00	.00	.00	.00	.00
2----	.66	305	295	.00	.00	.00	.00	.00	.00	.02
3----	.28	304	295	.00	.04	1.48	.36	.38	1.57	.38
4----	.46	305	295	.00	.00	.00	.00	.00	.00	.00
5----	.64	306	296	.00	.00	.00	.00	.00	.00	.00
6----	.58	307	296	.00	.00	.00	.00	.00	.00	.00
7----	.81	305	296	.00	.00	.00	.00	.00	.00	.00
8----	.61	304	294	.00	.00	.00	.00	.00	.00	.00
9----	.81	303	293	.00	.00	.00	.00	.00	.00	.00
10----	.66	303	292	.00	.00	.00	.00	.00	.00	.00
11----	.10	303	293	.00	.00	.00	.00	.00	.00	.00
12----	.30	303	294	.00	.00	.00	.00	.00	.00	.00
13----	.79	303	294	.21	.11	.00	.00	.00	.00	.00
14----	.18	302	296	.12	.04	.08	.18	.07	.00	.00

1/ Pan locations were Taylor Creek in November 1978 and Ft. Pierce in April through June 1979.

Soil moisture samples were collected at eight points for each site using the traverse scheme described by Jackson et al. (1980). Data were obtained at four depth intervals: 0-2.5, 2.5-5, 5-10, and 10-15 cm. Gravimetric samples that were gathered using an undisturbed core sampling device yielded estimates of the bulk densities, which are given in table 3.

Table 3.--Bulk density of soil samples by depth, Taylor Creek, Fla.

Site	Soil samples collected at depth of--			
	0-2.5 cm	2.5-5 cm	5-10 cm	10-15 cm
	G per cm^3			
F201	0.89	1.35	1.20	1.30
F202	.84	1.13	1.02	1.01
F203	1.20	1.40	1.27	1.16
F204	1.18	1.42	1.28	1.25
F205	1.02	1.50	1.33	1.42
F206	1.02	1.49	1.34	1.31
F304	.81	1.04	1.24	1.38
F305	1.10	1.35	1.32	1.39
F306	1.10	1.40	1.30	1.33
F307	.71	1.02	1.32	1.41
F308	.61	1.21	1.31	1.43
F310	.68	1.08	1.23	1.42

Ground water and water table depths are shallow in this area. The watershed is over the Floridian aquifer. As described in Speir et al. (1969), the ground water table is generally within 0.5 to 1 m of the surface. Maximum depths occur in the winter and spring and minimum depths primarily from June through October. Ground water wells are at all the rain gages shown in figure 1. Depths to the water table at the time of the flights are listed in table 4.

Table 4.--Ground water table depths on flight dates, Taylor Creek, Fla.

Date	Depth to ground water table at rain gage--						
	1	2	3	4	5	6	7
	M						
Nov. 30, 1978	0.68	0.82	1.19	1.04	0.99	1.22	1.06
May 2, 1979	.95	.93	1.26	1.19	1.15	1.30	1.08
May 22, 1979	.64	.81	.84	.71	.77	.69	.86
June 13, 1979	.93	1.10	1.01	.92	.97	.67	.96

Numerous hydrologic studies have been conducted on these watersheds. Additional information can be found in Speir et al. (1969), Allen et al. (1975), and U.S. Soil Conservation Service (1971).

Little River, Ga., Test Site

All sampling locations were within the Little River Experimental Watershed, which is monitored by the USDA-ARS Georgia Coastal Plain Experiment Station. The watershed is near Tifton, Ga., in the southern Coastal Plains physiographic region. Figure 5 is a map of the watershed.

The gaged watershed area encompasses 326 km^2 and is subdivided into nine smaller watersheds. Most of the area is gently sloping ranging from 0 to 5 percent. The land cover has about 33 percent in crops, 40 percent in woodlands, and 8 percent in urban categories. The primary crops are corn, soybeans, and peanuts. The soils are mostly loamy sands.

Three flightlines, referred to as F1, F2, and F4, were flown in 1979 on May 1, June 13, September 11, and November 19. Their locations within the watershed are shown in figure 5.

The sites covered by flightlines 1 and 2 are indicated in figure 6, which is an aerial photograph obtained in 1976, and sites covered by flightline 4 are in figure 7. Soils and land cover for each site are described in table 5.

Land-cover patterns within this area were typical of those observed elsewhere except where peanuts were growing. They were planted as a row crop and generally covered less than 50 percent of the ground until close to maturity. When mature, they were combined and left to dry. This resulted in about a 25 percent cover. Figure 8 illustrates the cover conditions on three dates for site G104 that were typical of the other sites.

Most of the soils in this area were well drained and in hydrologic soil group B. Only sites G404 and G406 were in type D soils. Data in other publications describing the hydraulic properties of the soils are in the Appendix. Additional information on the soils of this area can be found in U.S. Soil Conservation Service (1959).

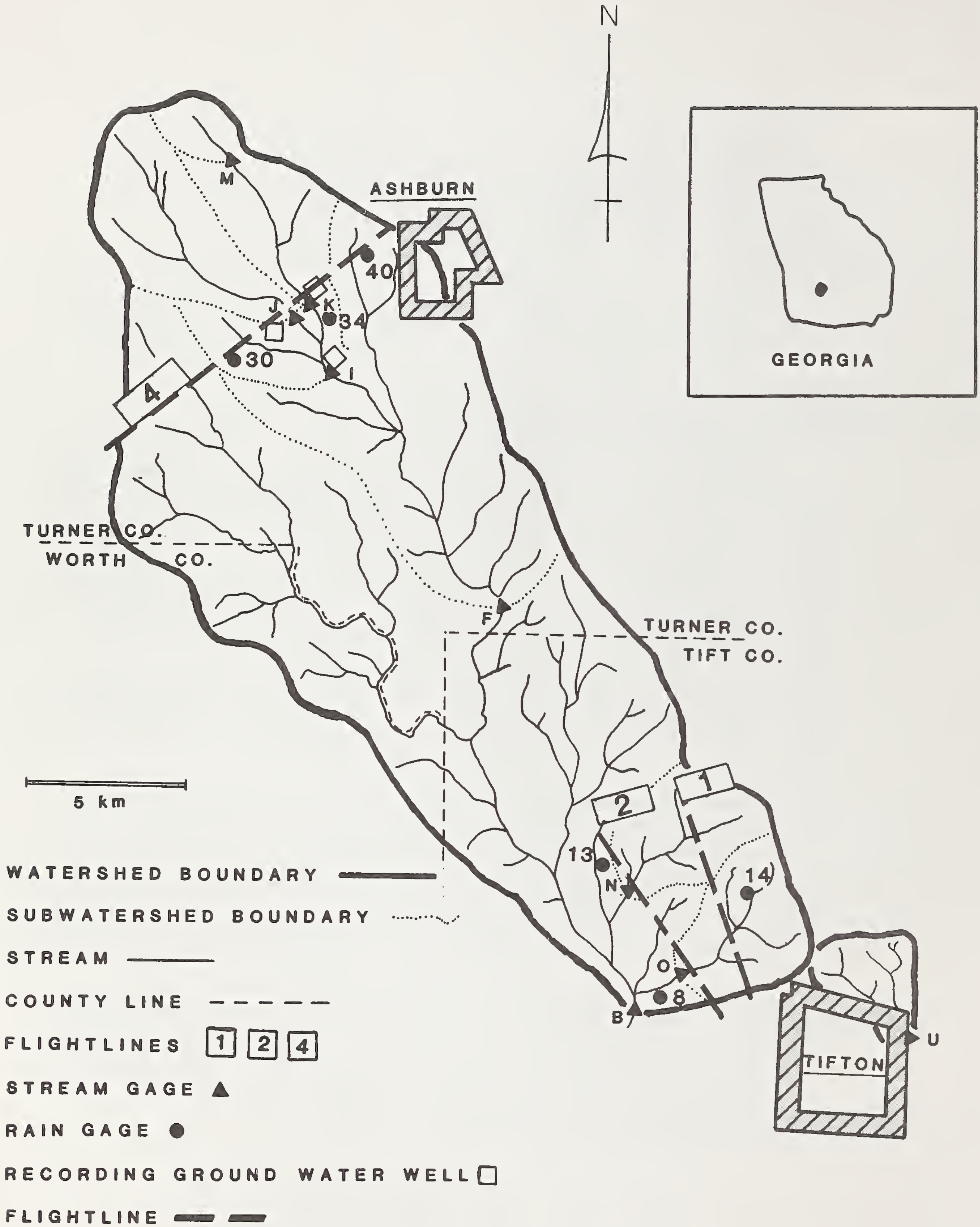

Figure 5.--Little River watershed, Ga.

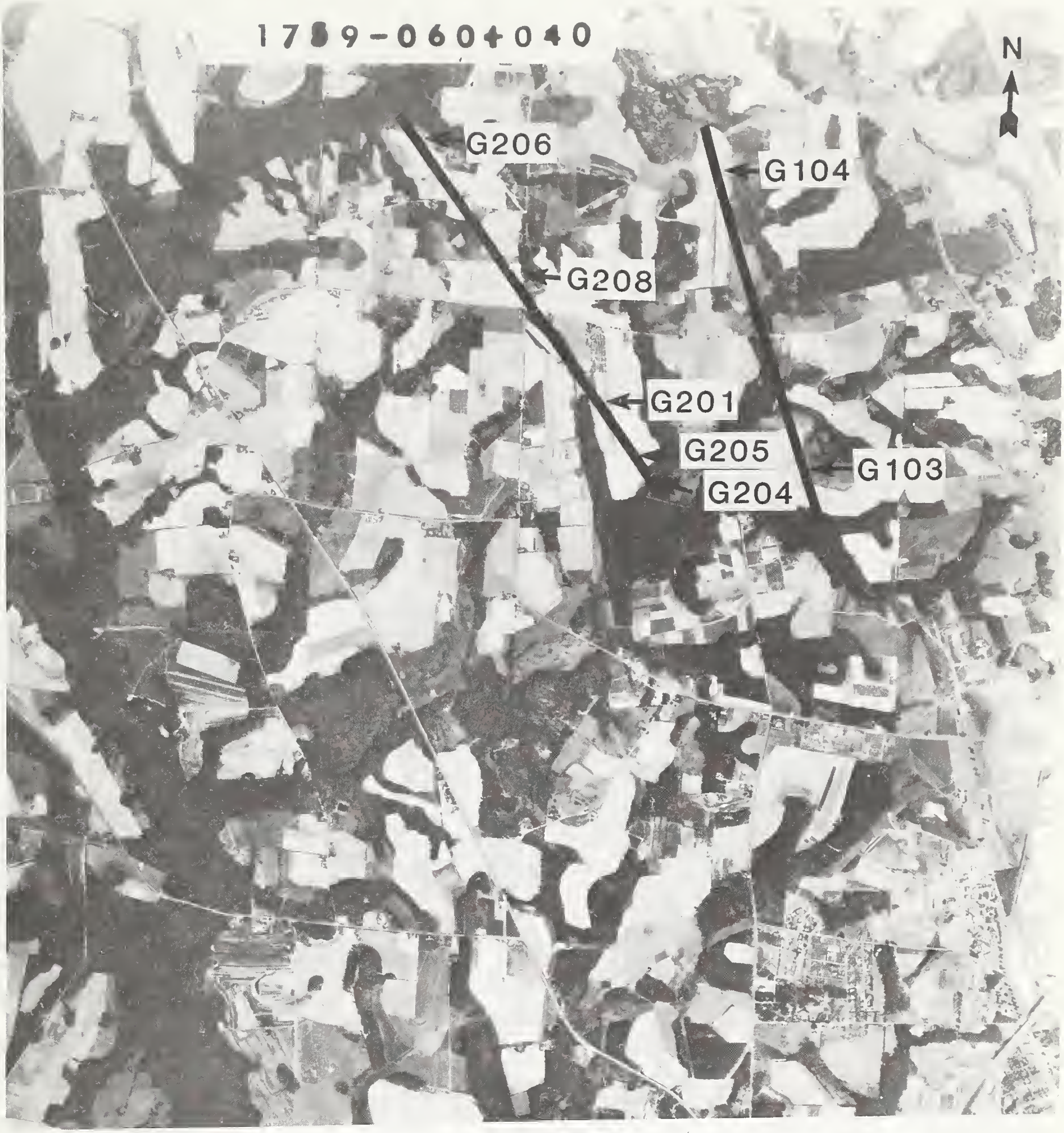

Figure 6.--Georgia sampling sites on flightlines 1 and 2 at 1:40,000 scale.

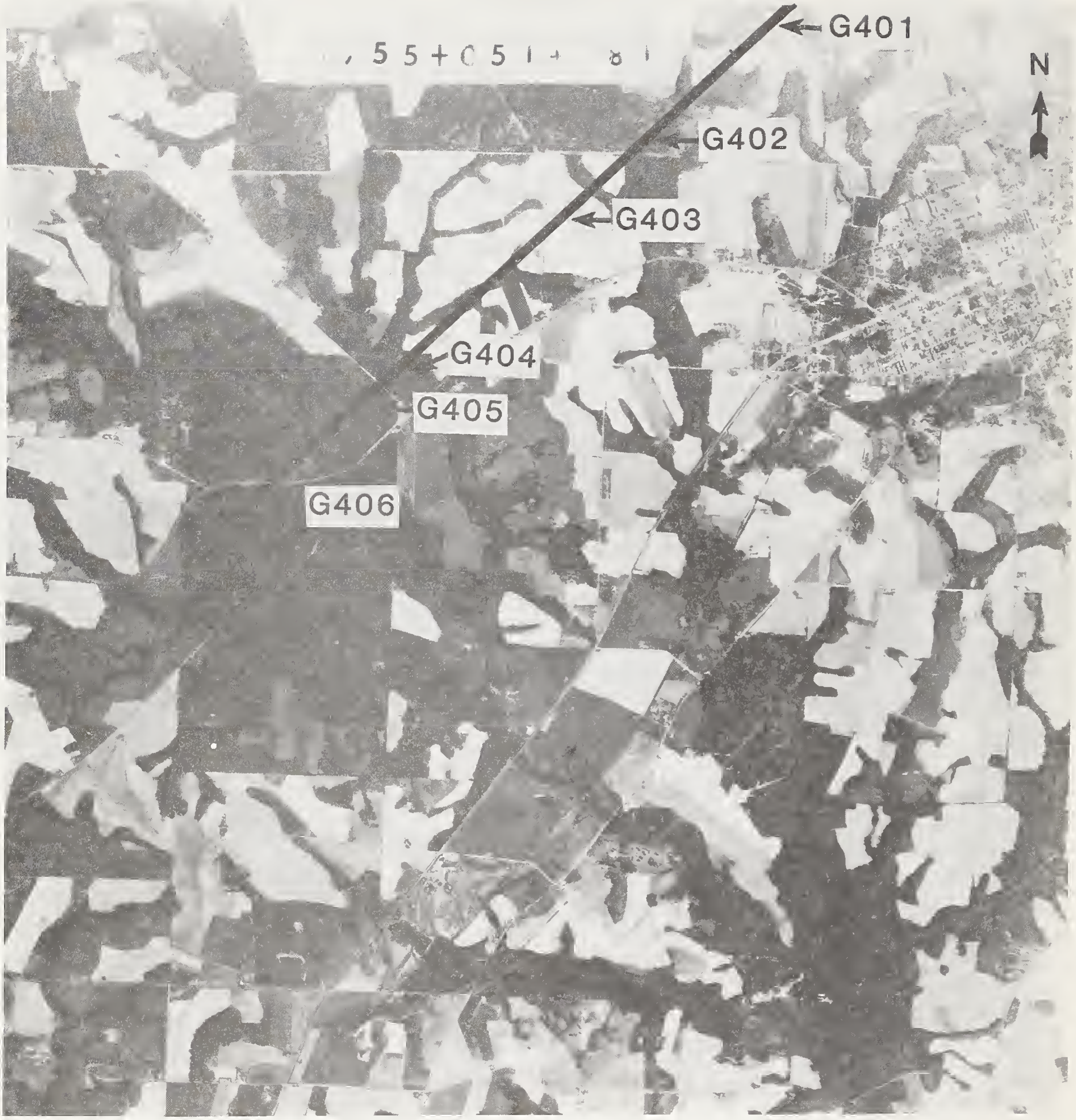

Figure 7.--Georgia sampling sites on flightline 4 at scale of 1:40,000.

Table 5.--Soil type and land cover by site, Little River watershed, Ga.

Site	Soil type	Land cover in 1979 on--			
		May 1	June 13	Sept. 11	Nov. 19
G103	Tifton loamy sand, sloping.	Grass, dense	Grass, dense	Grass, dense	Grass, dense.
G104	Tifton loamy sand, thick.	Fallow, freshly plowed.	Peanuts, 20 cm	Peanuts	Bare, combined peanuts.
G201	Norfolk loamy sand.	---	Corn, 180 cm	Corn	Corn stubble.
G204	do.	Corn, 30 cm	Corn, 150 cm	Corn stubble	Do.
G205	do.	Peanuts, 8 cm (10 percent cover).	Peanuts (75 percent cover).	Combined peanuts (50 percent cover).	Bare.
G206	Tifton loamy sand, eroded.	Corn, 50 cm	Corn, 240 cm	Corn	Corn stubble.
G208	Tifton loamy sand, sloping.	---	---	Peanuts (25 percent cover).	Combined peanuts.
G401	Tifton loamy sand.	Fallow, plowed	Soybeans	Soybeans	Soybeans.
G402	Leefield loamy sand.	Pine-hardwoods flood plain.	Pine-hardwoods flood plain.	Pine-hardwoods flood plain.	Pine-hardwoods flood plain.
G403	Tifton loamy sand.	Peanuts, small cover.	Peanuts (75 percent cover).	Peanuts	Combined peanuts.
G404	Alapaha loamy sand.	Pine-hardwoods flood plain.	Pine-hardwoods flood plain.	Pine-hardwoods flood plain.	Pine-hardwoods flood plain.
G405	Fuquay loamy sand.	Pine plantation, undergrowth.	Pine plantation, undergrowth.	Pine plantation, undergrowth.	Pine plantation, undergrowth.
G406	Alapaha loamy sand.	Pine plantation, light undergrowth.	Pine plantation, light undergrowth.	Pine plantation, light undergrowth.	Pine plantation, light undergrowth.

A

B

C

Figure 8.--Ground cover conditions for site G104 in 1979: A, May 1; B, June 13; C, Nov. 19.

A traverse sampling scheme was used to collect gravimetric soil moisture samples at eight points within each site. Data were obtained at four depth intervals: 0-2.5, 2.5-5, 5-10, and 10-15 cm. Soil moisture samples were collected within 2 hours of the aircraft flight time using a gravimetric core sampler, except under very dry conditions when a shovel was necessary. Samples were dried in a microwave oven. Bulk density samples obtained once for each site were as follows:

Site	Bulk density G per cm^3
G103	1.72
G104	1.46
G201	1.54
G204	1.54
G205	1.64
G206	1.41
G208	1.48
G401	1.54
G402	1.10
G403	1.44
G404	1.31
G405	1.49
G406	1.64

Little River is located in a humid area. Average daily temperature is 292 K (19° C), and average annual rainfall is 116 cm. Pan evaporation averages 141 cm a year and annual runoff 36 cm. Climatological data for the study are given in table 6.

Table 6.--Little River watershed, Ga., climatological data, 1979

Date		Pan evaporation	Daily temperature		Solar radiation	Rainfall at rain gage					
			Max.	Min.		8	13	14	30	34	40
		Cm	---Deg. K---		Ly per day	---------------Cm---------------					
Apr.	15---	0.43	298.9	282.8	601	0.00	0.00	0.00	0.00	0.00	0.00
	16---	.74	300.1	285.5	619	.00	.00	.00	.00	.00	.00
	17---	.69	298.9	286.1	589	.00	.00	.00	.00	.00	.00
	18---	.38	300.0	284.4	491	.00	.00	.00	.00	.00	.00
	19---	.48	299.4	282.8	523	.00	.00	.00	.00	.00	.00
	20---	.64	300.6	286.1	566	.00	.00	.00	.00	.00	.00
	21---	.56	301.1	287.2	495	.00	.00	.00	.00	.00	.00
	22---	.64	300.6	289.4	449	.00	.00	.00	.00	.00	.00
	23---	.66	300.0	289.4	375	.00	.00	.00	.00	.00	.00
	24---	.53	300.0	290.1	179	.51	.51	.51	.00	.76	.25
	25---	.18	296.7	289.4	161	4.83	4.83	4.06	---	4.06	3.81
	26---	.18	297.2	289.4	281	.51	.25	.25	---	.76	.76
	27---	.33	289.9	290.0	475	.00	.00	.00	---	.00	.00
	28---	.58	296.7	286.1	594	.00	.00	.00	---	.00	.00
	28---	.58	297.2	281.1	586	.00	.00	.25	---	.00	.00
	30---	.56	296.7	286.1	512	.00	.00	.00	---	.00	.00
May	1---	.56	299.4	286.7	492	.00	.00	.00	---	.00	.00
	2---	.51	300.0	286.1	450	.00	.00	.00	---	.00	.00
	3---	.74	301.7	288.9	470	.00	.00	.00	---	.00	.00
June	1---	.74	304.4	291.7	520	.00	.25	.25	.25	.00	.00
	2---	.41	304.4	293.9	549	.00	.00	.00	.00	.00	.00
	3---	.74	305.6	295.0	464	.00	.25	.00	.00	.00	.00
	4---	.66	304.4	295.0	470	.51	1.02	1.27	.00	.00	.00
	5---	.51	303.3	292.8	571	.00	.00	.00	.00	.00	.00
	6---	.64	304.4	292.8	523	.25	.00	.25	.00	.00	.00
	7---	.33	305.6	296.1	391	1.78	.25	.25	1.02	3.05	4.06
	8---	.84	306.7	296.1	388	1.02	.25	.51	.51	1.27	1.02
	9---	.58	305.0	292.8	529	.00	.00	.00	.00	.00	.00
	10---	.69	303.9	291.1	604	.00	.00	.00	.00	.00	.00
	11---	.79	305.0	294.4	566	.00	.00	.00	.00	.00	.00
	12---	.66	303.3	289.4	654	.00	.00	.00	.00	.00	.00
	13---	1.12	301.1	286.7	613	.00	.00	.00	.00	.00	.00
	14---	.86	302.8	287.8	328	.00	.00	.00	.00	.00	.00
	15---	.66	300.0	291.1	148	.25	.25	.00	.00	.00	.00

Table 6.--Little River watershed, Ga., climatological data, 1979--Continued

Date	Pan evaporation	Daily temperature Max.	Daily temperature Min.	Solar radiation	Rainfall at rain gage 8	13	14	30	34	40
	Cm	---Deg. K---		Ly per day	---Cm---					
Sept. 1---	0.64	305.0	294.4	440	0.00	1.27	0.51	0.25	0.00	0.00
2---	.56	306.1	295.0	385	.51	.76	.76	2.54	.51	.51
3---	.36	305.6	295.0	383	.51	.25	.25	.00	.25	.00
4---	.56	305.0	296.1	107	.00	.00	.00	.00	.00	.00
5---	.25	300.0	295.6	461	.00	.00	.00	.00	.00	.00
6---	.66	306.7	296.1	354	.00	.00	.00	.00	.00	.00
7---	.48	307.2	295.0	382	---	.00	.00	.00	.00	.00
8---	.53	306.7	292.8	433	---	.00	.00	.00	.00	.00
9---	.58	306.7	293.3	294	---	.00	.00	.00	.00	.00
10---	.51	301.7	291.1	448	---	.00	.00	.00	.00	.00
11---	.53	303.3	291.7	325	---	.00	.00	.00	.00	.00
12---	.51	305.0	296.1	208	---	1.78	2.03	1.78	2.29	2.54
13---	.28	303.9	295.6	268	.76	.25	.00	.00	.00	.00
Nov. 1---	.38	302.2	291.1	186	.25	.00	.25	.51	.51	.25
2---	.23	300.0	292.2	170	2.29	1.52	2.29	4.57	2.29	2.54
3---	.28	301.1	283.3	395	.00	.00	.00	.00	.00	.00
4---	.53	293.3	280.0	394	.00	.00	.00	.00	.00	.00
5---	.56	291.1	278.3	363	.00	.00	.00	.00	.00	.00
6---	.20	293.9	282.2	247	.00	.00	.00	.00	.00	.00
7---	.25	296.7	279.4	355	.00	.00	.00	.00	.00	.00
8---	.28	295.6	279.4	313	.00	.00	.00	.00	.00	.00
9---	.20	296.7	285.0	326	.00	.00	.00	.00	.00	.00
10---	.23	300.0	287.2	123	1.27	1.52	1.02	.51	.51	.51
11---	.20	298.9	290.6	44	6.35	5.59	5.59	5.08	5.08	4.06
12---	.20	290.6	288.3	116	.00	.00	.00	.00	.00	.00
13---	.18	292.8	285.6	246	.00	.00	.00	.00	.00	.00
14---	.43	291.7	277.2	351	.00	.00	.00	.00	.00	.00
15---	.23	290.0	274.4	354	.00	.00	.00	.00	.00	.00
16---	.18	290.0	276.7	342	.00	.00	.00	.00	.00	.00
17---	.25	293.9	281.1	331	.00	.00	.00	.00	.00	.00
18---	.20	297.2	279.4	270	.00	.00	.00	.00	.00	.00
19---	.36	296.1	280.0	320	.00	.00	.00	.00	.00	.00
20---	.23	297.2	280.0	321	.00	.00	.00	.00	.00	.00
21---	.23	297.8	281.7	278	.00	.00	.00	.00	.00	.00

Ground water table depths were monitored at several locations in the watershed. Three of these sites were at watershed runoff gages near the flightlines used in this study. Observed values are in table 7.

Table 7.--Ground water table depths on 4 flight dates, Little River watershed, Ga., 1979

Date	Ground water table depths at stream gage--		
	I	J	K
	M		
May 1---------	0.55	0.09	0.35
June 13---------	.66	.44	.48
Sept. 11---------	.82	.81	.73
Nov. 19---------	.56	.11	.35

REMOTE SENSING SYSTEMS

The NASA 929 (C-130B) aircraft was the sensor platform used in these experiments. A nominal altitude of 305 m (1,000 ft) and a ground speed of 278 km per hour (150 knots) were chosen. The sensor configuration included color infrared photography, a modular multispectral scanner, a thermal infrared radiometer, C (5.00 GHz) and L band (1.41 GHz) radiometers, a passive microwave scanner, and four active microwave sensors: K, C, L, and P band scatterometers. C and L band radiometer observations were made at look angles of 0 and 40 degrees. L band data were collected for only a horizontal polarization (hor. polar.), and C band data were collected for both horizontal and vertical polarizations (vert. polar.).

These sensors were described by Jackson et al. (1980). Some changes have been made in the aircraft systems by NASA since the May 1978 flights described in that report. The K band radiometers were removed; the C band sensor was mounted in the nose and the L band on the rear platform of the plane.

SOIL MOISTURE OBSERVATIONS

Gravimetric soil moisture data for each depth interval were combined with the site bulk density values to compute the volumetric soil moisture. Depth interval values were combined to obtain the following measurements: 0-2.5, 2.5-5, 5-10, and 10-15 cm. The results are summarized in table 8. Note that 100 percent soil moisture indicates standing water.

It was apparent from the samples obtained at the Florida sites that the typical soil moisture profile was inverted, decreasing with depth. This is not unusual when there is frequent rainfall; however, the divergence between the moisture contents, ranging between 10 and 20 percent, suggested that the soil properties of these layers were very different. Qualitative observations of the organic content and the difference in the bulk density values in table 3 for these layers supported this conclusion.

Climatic conditions and ground water table levels at the Florida sites would support the hypothesis that on most of the sampling dates the soil moisture was very close to field capacity. Generally this is the moisture associated with a tension of 0.33 bar; however, for sandy soils a value at 0.10 bar may be more representative. If a condition near field capacity existed throughout the profile, moisture-tension relationships would be very different between layers.

Very little information is available to evaluate the properties of shallow surface layers for these soils. Only one study had been conducted on this subject in which organic soils were considered (Stewart et al., 1963). One approach that can be used was described by Gupta and Larson (1979). They developed prediction equations for moisture contents at specified tensions. These equations utilize readily available data, including sand (SA), silt (SI), clay (C), and organics (O) in percentages and the bulk density (B) in grams per cubic centimeter.

Data for the required soil properties are given in the Appendix for several of the soils. As an example, for a Myakka fine sand, SA = 93 percent, SI = 4 percent, C = 3 percent, O = 2 percent, and B = 1.3 grams per cubic centimeter. The value of the bulk density is comparable to that observed in the lower layers of the Florida sites. Using the equations given in Gupta and Larson (1979), the values predicted for volumetric moisture contents at 15 bar (M_{15}), 0.33 bar ($M_{0.33}$), and 0.1 bar ($M_{0.1}$) were 5.6, 15, and 22 percent, respectively. Values of $M_{0.33}$ and $M_{0.1}$ corresponded to those observed in the lower soil layers.

Table 8.--Soil moisture observations at Florida and Georgia, 1978 and 1979

DATE	SITE	VOLUMETRIC SOIL MOISTURE (PERCENT) AT INDICATED DEPTHS							
		0-2.5 CM		2.5-5 CM		5-10 CM		10-15 CM	
		MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
<u>1978</u>				FLORIDA					
NOV. 30----	F201	17.0	10.0	19.8	8.5	20.9	7.0	21.7	7.6
	F202	24.6	9.6	31.0	9.3	22.3	6.8	23.5	6.3
	F203	15.8	10.0	17.7	6.6	18.0	4.8	19.6	4.6
	F204	23.8	11.4	26.4	8.1	15.4	4.8	16.8	4.1
	F205	29.8	13.5	26.7	12.0	19.1	6.5	18.0	4.8
	F206	27.7	22.3	24.8	21.6	13.9	11.6	12.1	10.5
	F304	38.4	12.1	34.1	10.2	25.2	11.2	17.5	8.7
	F305	23.5	13.1	21.2	10.7	15.2	7.5	10.1	4.8
	F306	---	---	---	---	---	---	---	---
	F307	39.3	8.2	30.9	4.8	26.9	3.3	20.2	2.3
	F308	48.5	7.8	38.2	2.7	25.3	2.6	21.5	2.4
	F309	100.0	---	100.0	---	100.0	---	100.0	---
	F310	37.3	11.2	32.2	7.8	22.9	5.6	20.7	4.7
	F312	100.0	---	100.0	---	100.0	---	100.0	---
<u>1979</u>									
MAY 2------	F201	30.0	9.5	31.2	9.9	26.5	9.9	24.8	7.4
	F202	36.0	6.7	38.6	6.7	31.1	6.8	31.6	9.8
	F203	34.3	5.5	28.7	4.2	26.6	7.6	21.7	3.6
	F204	33.5	5.1	31.3	6.5	27.6	5.3	26.2	5.1
	F205	34.5	16.8	26.3	10.8	19.9	7.9	19.5	7.2
	F206	25.2	16.0	20.4	12.0	12.7	6.3	12.2	6.2
	F304	29.4	7.4	28.2	17.8	22.5	13.7	16.0	11.2
	F305	23.3	9.6	22.4	8.0	16.4	5.1	10.8	3.9
	F306	28.9	7.3	27.4	7.9	21.7	6.2	18.7	6.3
	F307	26.3	5.2	19.2	3.5	14.9	3.0	12.6	1.9
	F308	32.9	15.4	23.3	6.5	17.2	2.0	13.7	3.1
	F309	100.0	---	100.0	---	100.0	---	100.0	---
	F310	34.6	4.1	25.2	3.0	18.1	1.4	17.9	3.8
	F312	100.0	---	100.0	---	100.0	---	100.0	---
MAY 22-----	F201	26.1	10.7	25.6	7.7	23.0	6.0	27.3	8.2
	F202	32.6	11.0	38.6	13.8	35.1	10.0	37.7	12.4
	F203	20.6	4.0	20.8	3.8	18.3	3.1	18.1	3.1
	F204	30.8	15.0	33.0	13.3	26.1	7.9	24.4	8.7
	F205	27.3	16.9	25.4	11.6	18.3	7.7	19.7	6.1
	F206	29.8	21.8	24.8	19.0	16.5	12.0	16.6	10.4
	F304	37.9	6.7	36.1	6.6	27.4	4.6	23.6	2.7
	F305	32.8	10.8	27.9	8.9	21.8	7.9	17.5	7.1
	F306	24.5	10.7	28.1	12.5	17.3	5.7	15.1	6.5
	F307	25.0	4.0	25.7	5.0	20.8	2.8	16.2	1.9
	F308	21.3	4.1	20.3	4.5	14.4	2.2	12.9	2.2
	F309	100.0	---	100.0	---	100.0	---	100.0	---
	F310	22.6	4.7	24.1	4.3	17.7	2.6	16.7	2.9
	F312	100.0	---	100.0	---	100.0	---	100.0	---
JUNE 13----	F201	22.7	21.6	23.8	17.2	21.7	11.8	27.4	12.1
	F202	23.7	14.5	35.0	16.3	29.9	14.8	35.1	11.0
	F203	14.5	4.1	16.1	2.7	16.1	4.3	20.4	6.0
	F204	22.4	14.4	26.9	11.8	23.5	13.2	25.1	10.5
	F205	14.9	10.2	14.0	7.7	10.2	6.8	12.1	8.9
	F206	25.8	24.6	22.4	20.4	13.0	11.3	14.5	13.4
	F304	34.5	6.6	32.6	12.0	26.1	11.9	20.9	9.7
	F305	25.4	12.3	23.6	11.9	17.9	6.8	12.1	4.7
	F306	21.1	10.4	24.6	10.2	16.9	7.6	14.6	7.2
	F307	18.3	3.6	19.2	2.9	15.9	1.9	13.9	2.1
	F308	13.9	3.4	7.8	3.7	5.3	2.1	6.4	2.8
	F309	100.0	---	100.0	---	100.0	---	100.0	---
	F310	13.8	5.0	11.5	3.8	11.3	4.0	9.8	3.3
	F312	100.0	---	100.0	---	100.0	---	100.0	---

Table 8.--Soil moisture observations at Florida and Georgia, 1978 and 1979--Continued

DATE	SITE	0-2.5 CM MEAN	0-2.5 CM STANDARD DEVIATION	2.5-5 CM MEAN	2.5-5 CM STANDARD DEVIATION	5-10 CM MEAN	5-10 CM STANDARD DEVIATION	10-15 CM MEAN	10-15 CM STANDARD DEVIATION
1979					GEORGIA				
MAY 1	G103	28.8	17.7	20.8	6.1	20.6	4.4	21.0	6.4
	G104	4.5	2.5	7.3	2.1	9.1	1.5	9.1	1.4
	G204	8.5	6.6	11.4	5.5	12.7	6.3	13.5	7.0
	G205	2.6	1.1	8.9	1.3	9.6	1.9	11.4	2.2
	G206	1.7	.5	8.3	1.7	9.3	2.6	10.0	2.2
	G401	6.1	.9	10.8	1.7	11.9	1.4	12.5	1.6
	G402	52.0	46.4	42.5	42.2	37.6	41.4	45.0	40.4
	G403	4.7	2.0	8.9	1.8	10.3	1.7	11.1	1.3
	G404	76.3	19.2	71.5	22.3	61.3	21.6	55.2	24.8
	G405	9.5	3.2	8.9	1.1	9.1	.9	9.0	1.1
	G406	14.0	6.0	11.9	3.7	11.6	2.8	12.0	3.8
JUNE 13	G103	10.4	13.9	8.8	3.6	10.7	4.2	11.5	5.2
	G104	1.6	.9	5.4	2.2	6.2	2.4	7.2	1.7
	G201	2.2	.8	6.5	2.9	6.1	1.7	6.6	1.2
	G204	12.8	3.4	15.0	2.3	16.2	2.1	15.9	3.3
	G205	1.8	.7	4.7	1.1	5.3	1.5	6.4	2.1
	G206	3.5	1.2	5.1	1.4	5.4	1.4	5.6	1.3
	G401	5.6	4.2	9.2	3.8	10.1	4.9	11.0	4.2
	G402	26.7	21.7	20.8	15.2	17.3	10.7	17.1	10.3
	G403	3.0	1.4	6.5	1.3	8.7	2.1	9.0	1.0
	G404	65.4	22.6	50.6	19.3	46.2	15.4	38.8	11.8
	G405	8.1	2.0	7.1	1.1	7.0	1.3	7.2	1.1
	G406	9.4	3.4	8.4	2.2	9.2	2.7	10.1	2.8
SEPT. 11	G103	10.4	7.6	12.5	5.9	13.6	5.1	13.5	4.2
	G104	4.5	6.6	3.0	1.3	3.4	1.2	3.6	1.0
	G201	5.2	3.6	7.5	3.4	8.9	3.9	9.7	3.9
	G204	2.7	1.4	5.3	1.6	6.2	2.2	6.2	1.7
	G205	3.2	1.6	7.3	.7	7.7	1.2	8.2	1.0
	G206	4.2	3.7	4.2	1.0	5.0	1.1	4.9	1.4
	G208	3.1	1.2	4.5	1.0	4.5	1.4	4.4	1.1
	G401	3.8	1.4	6.4	1.3	7.4	1.5	8.3	1.5
	G402	20.0	18.2	12.2	6.5	9.7	3.8	9.5	4.0
	G403	1.9	.9	2.7	.6	4.1	2.4	4.1	2.1
	G404	48.2	27.4	34.0	15.6	26.2	12.6	23.2	9.9
	G405	7.3	4.1	5.5	1.9	5.6	2.0	6.2	2.2
	G406	11.0	16.7	6.8	2.0	6.7	1.4	7.4	1.0
NOV. 19	G103	17.0	10.3	16.6	6.2	16.6	4.4	18.3	4.7
	G104	4.5	1.2	6.5	1.3	7.7	1.5	8.3	1.4
	G201	8.9	1.5	12.1	1.9	12.7	2.6	14.4	3.2
	G204	12.6	5.5	14.2	4.0	14.6	4.2	16.6	7.4
	G205	4.3	2.3	7.9	.7	8.7	.5	9.5	1.0
	G206	11.1	3.2	12.8	4.9	11.3	3.7	13.4	2.7
	G208	5.8	1.9	8.6	.7	9.3	.4	10.1	.7
	G401	8.2	.5	10.1	1.6	10.5	.9	10.3	1.4
	G402	39.5	45.8	24.9	21.5	21.6	16.7	21.0	15.5
	G403	4.9	.2	7.0	.6	8.5	.9	8.6	.7
	G404	55.8	26.1	43.1	19.2	34.1	20.9	34.7	22.8
	G405	13.4	10.9	7.7	1.4	9.2	3.6	8.4	1.8
	G406	14.0	6.4	10.1	1.7	10.1	1.8	10.1	1.6

To evaluate the moisture tension in the surface layer, it was assumed that all the properties of this layer except the bulk density were the same as for the lower layers. A value of B = 0.7 was used for the surface layer. The impact of this change on the volumetric moisture contents associated with the tensions was significant. Values of 4, 24, and 37 percent were predicted for M_{15}, $M_{0.33}$, and $M_{0.1}$, respectively. The value of $M_{0.1}$ was on the order of those observed in the surface layer.

These calculations show that the moisture profiles at the Florida sites could be explained by differences in the moisture-tension properties of the layers. Based on the computed values, the observed moisture profiles could be in a condition near hydraulic equilibrium.

REMOTE SENSING DATA

All data were processed as described by Jackson et al. (1980). Separate time corrections had to be applied to the C and L band systems at 40 degrees because the C band looked forward and the L band looked backward. Passive Microwave Imaging system data were not processed since they have not been useful in previous studies because of the inability of the short wavelength used to penetrate vegetation.

Soil temperature averages for 2.5- and 10-cm measurements and precision thermal radiometer data (PRT5) are listed in table 9. C and L band passive microwave radiometer data are given in table 10 and the scatterometer data in table 11. The scatterometer data set is smaller than the others since several sites were considered unsuitable because the time frames were too short for reliable estimates with this system.

Data collected by the C band scatterometer were not reliable at look angles less than 20 degrees. Difficulties with the antenna gain patterns created problems in interpreting these observations.

DATE	SITE	SOIL TEMPERATURE AT -- 2.5 CM DEPTH	10 CM DEPTH	PRT5 TEMPERATURE
		DEG. K		
1978		FLORIDA		
NOV. 30	F201	296.0	295.0	301.8
	F202	---	---	300.2
	F203	---	---	299.7
	F204	---	---	299.8
	F205	---	---	299.6
	F206	---	---	299.5
	F304	298.0	297.0	302.2
	F305	---	---	301.4
	F306	---	---	299.5
	F307	298.0	297.0	300.2
	F308	---	---	300.8
	F309	---	---	299.0
	F310	---	---	301.4
	F312	---	---	300.3
1979				
MAY 2	F201	---	---	300.7
	F202	---	---	300.3
	F203	---	---	299.7
	F204	---	---	299.1
	F205	---	---	299.1
	F206	---	---	299.3
	F304	309.0	299.0	301.0
	F305	---	299.0	299.8
	F306	---	---	298.7
	F307	301.0	295.0	303.6
	F308	---	---	301.4
	F309	297.5	297.5	297.5
	F310	---	---	303.1
	F312	---	---	304.4
MAY 22	F201	---	---	301.0
	F202	---	---	301.2
	F203	297.0	296.0	300.2
	F204	---	---	300.0
	F205	---	---	300.3
	F206	---	---	300.6
	F304	---	---	302.9
	F305	---	---	302.8
	F306	---	---	299.9
	F307	299.0	297.0	303.4
	F308	---	---	303.1
	F309	---	---	299.0
	F310	---	---	304.8
	F312	---	---	299.7
JUNE 13	F201	---	---	300.7
	F202	---	---	299.1
	F203	---	---	298.8
	F204	315.0	306.0	298.2
	F205	---	---	298.7
	F206	---	---	298.4
	F304	311.0	305.0	301.8
	F305	---	---	299.2
	F306	---	---	300.7
	F307	305.0	301.0	299.8
	F308	---	---	302.6
	F309	---	---	300.3
	F310	---	---	305.8
	F312	---	---	301.5

Table 9.-- Temperature data for Florida and Georgia sites--Continued

DATE	SITE	SOIL TEMPERATURE AT -- 2.5 CM DEPTH	SOIL TEMPERATURE AT -- 10 CM DEPTH	PRT5 TEMPERATURE
		DEG. K		
1979		GEORGIA		
MAY 1	G103	---	---	296.7
	G104	306.0	300.0	300.5
	G201	---	---	---
	G204	302.0	300.0	303.2
	G205	304.0	302.0	298.6
	G206	310.0	305.0	300.7
	G208	---	---	---
	G401	309.0	302.0	298.9
	G402	298.0	296.0	296.5
	G403	303.0	301.0	298.4
	G404	291.0	290.0	296.0
	G405	294.0	292.0	299.2
	G406	293.0	292.0	298.1
JUNE 13	G103	305.0	303.0	304.9
	G104	303.0	300.0	309.7
	G201	299.0	298.0	303.0
	G204	299.0	301.0	303.5
	G205	305.0	304.0	305.3
	G206	300.0	297.0	302.3
	G208	---	---	---
	G401	307.0	304.0	310.2
	G402	301.0	297.0	302.5
	G403	308.0	302.0	307.4
	G404	295.0	293.0	304.0
	G405	296.0	295.0	302.0
	G406	297.0	295.0	302.3
SEPT. 11	G103	---	---	302.6
	G104	---	---	300.3
	G201	298.0	297.0	300.4
	G204	299.0	297.0	299.7
	G205	302.0	301.0	304.5
	G206	305.0	303.0	299.3
	G208	309.0	307.0	298.0
	G401	298.1	298.1	298.1
	G402	303.0	301.0	299.1
	G403	---	---	303.3
	G404	---	295.0	297.2
	G405	---	296.0	299.1
	G406	297.0	296.0	298.7
NOV. 19	G103	---	---	294.8
	G104	---	---	303.5
	G201	---	---	299.1
	G204	---	---	305.9
	G205	---	---	297.6
	G206	---	---	299.0
	G208	---	---	298.3
	G401	---	---	299.6
	G402	---	---	295.2
	G403	---	---	297.5
	G404	---	---	292.8
	C405	---	---	293.7
	G406	---	---	293.6

Table 10.--Microwave radiometer data for Florida and Georgia sites

DATE	SITE	BRIGHTNESS TEMPERATURE: L BAND, 0 DEG. LOOK ANGLE, HOR. POLAR.	L BAND, 40 DEG. LOOK ANGLE, HOR. POLAR.	C BAND, 0 DEG. LOOK ANGLE, HOR. POLAR.	C BAND, 0 DEG. LOOK ANGLE, VERT. POLAR.	C BAND, 40 DEG. LOOK ANGLE, HOR. POLAR.	C BAND, 40 DEG. LOOK ANGLE, VERT. POLAR.
		DEG. K					
1978		FLORIDA					
NOV. 30	F201	272.7	270.3	287.5	288.9	282.7	277.1
	F202	272.4	274.2	287.2	288.0	282.7	277.5
	F203	269.0	274.3	287.6	288.6	283.7	278.7
	F204	270.6	274.8	286.9	289.7	283.3	277.4
	F205	262.0	269.1	286.3	288.9	282.7	276.3
	F206	272.9	272.5	288.5	290.3	283.1	277.5
	F304	245.5	233.0	280.1	281.9	272.8	76.8
	F305	273.4	261.2	287.1	289.6	281.8	274.6
	F306	271.6	275.0	285.4	287.8	280.3	274.2
	F307	247.9	237.6	283.3	285.7	273.9	275.1
	F308	246.7	234.3	285.6	287.7	282.9	280.7
	F309	220.9	235.5	260.3	263.5	266.6	264.3
	F310	229.5	214.2	278.6	280.8	269.4	271.3
	F312	249.9	---	274.6	276.4	---	---
1979							
MAY 2	F201	277.4	277.3	---	---	277.9	272.7
	F202	270.3	272.9	---	---	277.7	272.2
	F203	274.1	275.6	---	---	279.4	273.3
	F204	269.3	273.1	---	---	280.0	273.0
	F205	266.1	268.5	---	---	279.5	272.4
	F206	271.9	274.0	---	---	279.3	272.2
	F304	258.6	242.0	280.2	282.0	271.4	271.9
	F305	251.2	247.0	276.0	275.4	272.8	267.3
	F306	269.5	270.0	279.5	280.1	276.7	269.6
	F307	259.2	241.8	279.8	281.0	276.7	275.1
	F308	272.8	259.9	287.3	287.8	280.4	276.2
	F309	261.6	258.1	279.4	281.8	277.2	270.0
	F310	254.4	226.4	277.9	279.9	274.2	271.6
	F312	267.2	266.2	280.2	278.2	275.5	268.6
MAY 22	F201	277.4	277.5	---	---	---	---
	F202	276.8	277.7	---	---	---	---
	F203	273.9	278.3	---	---	---	---
	F204	273.0	277.3	---	---	---	---
	F205	263.2	270.9	---	---	---	---
	F206	268.0	269.2	---	---	---	---
	F304	241.4	---	---	---	---	---
	F305	253.8	---	---	---	---	---
	F306	269.5	---	---	---	---	---
	F307	251.1	---	---	---	---	---
	F308	278.7	---	---	---	---	---
	F309	220.7	---	---	---	---	---
	F310	259.5	---	---	---	---	---
	F312	204.8	---	---	---	---	---
JUNE 13	F201	268.2	262.9	284.9	290.0	279.1	273.8
	F202	282.6	279.1	287.9	293.3	283.8	275.9
	F203	279.9	278.7	288.4	294.0	283.8	277.3
	F204	280.5	281.7	287.9	293.9	283.9	277.7
	F205	273.3	275.6	285.4	289.5	282.8	275.8
	F206	274.3	274.6	285.6	291.3	282.1	275.1
	F304	253.4	250.4	279.6	287.1	273.7	275.6
	F305	251.3	247.4	281.9	290.2	281.1	274.8
	F306	273.0	271.7	286.3	290.9	279.6	272.5
	F307	264.9	264.9	287.7	293.9	284.8	280.0
	F308	282.7	281.5	293.3	298.3	285.9	280.8
	F309	271.8	257.8	290.4	297.0	280.7	272.8
	F310	277.5	273.9	288.7	294.7	284.8	281.1
	F312	257.4	264.3	267.5	272.6	268.2	263.2

Table 10.--Microwave radiometer data for Florida and Georgia sites--Continued

		BRIGHTNESS TEMPERATURE					
		L BAND		C BAND			
				0 DEG. LOOK ANGLE		40 DEG. LOOK ANGLE	
DATE	SITE	0 DEG. LOOK ANGLE HOR. POLAR.	40 DEG. LOOK ANGLE HOR. POLAR.	HOR. POLAR.	VERT. POLAR.	HOR. POLAR.	VERT. POLAR.
		DEG. K					
1979		GEORGIA					
MAY 1	G104	287.4	---	284.1	286.8	---	---
	G201	---	---	---	---	---	---
	G204	293.5	---	283.8	285.8	---	---
	G205	286.8	286.4	279.6	279.1	264.9	271.2
	G206	285.5	284.4	271.1	271.5	271.5	271.8
	G208	---	---	---	---	---	---
	G401	251.8	269.8	270.1	272.5	272.3	269.7
	G402	266.7	272.7	276.5	271.3	282.3	284.9
	G403	287.9	283.6	277.8	282.6	269.2	273.2
	G404	266.6	270.6	274.1	269.6	279.7	280.9
	G405	272.2	268.4	281.4	282.0	277.7	272.0
	G406	---	269.2	---	---	278.3	272.6
JUNE 13	G103	277.4	275.9	282.3	287.3	274.9	275.6
	G104	293.7	289.1	288.6	291.0	278.3	276.9
	G201	293.1	289.3	286.0	291.1	275.8	274.0
	G204	274.5	---	284.8	288.9	---	---
	G205	291.6	289.7	284.8	288.0	279.1	273.3
	G206	291.4	278.8	286.4	287.6	276.8	273.3
	G208	---	---	---	---	---	---
	G401	291.4	288.6	287.5	291.7	280.2	276.9
	G402	268.9	269.4	286.5	292.1	284.1	276.0
	G403	290.4	286.0	284.8	290.2	280.4	274.1
	G404	---	270.5	---	---	280.1	274.6
	G405	---	270.0	---	---	283.4	275.5
	G406	276.4	269.6	288.5	294.0	283.8	276.6
SEPT. 11	G103	278.8	269.1	277.2	286.3	271.6	268.4
	G104	291.1	288.2	280.4	285.3	271.3	266.7
	G201	283.0	286.2	279.5	285.3	273.2	269.1
	G204	---	---	---	---	---	---
	G205	287.4	289.9	281.6	289.3	271.5	272.5
	G206	285.4	282.3	282.1	288.6	277.2	274.8
	G208	280.7	286.0	280.0	285.1	273.2	267.0
	G401	286.7	283.7	281.5	288.7	279.8	271.5
	G402	---	276.5	---	---	282.9	275.1
	G403	288.2	283.8	280.0	287.9	273.8	270.4
	G404	276.0	272.8	282.2	289.8	279.6	271.5
	G405	281.2	273.8	286.6	293.5	282.0	275.4
	G406	278.2	273.4	285.9	294.3	282.1	274.4
NOV. 19	G103	260.1	250.4	269.4	276.4	265.2	261.3
	G104	268.7	261.[illegible]	271.5	277.8	257.9	264.3
	G201	266.8	272.7	259.0	264.8	266.0	264.6
	G204	261.2	263.2	268.7	276.4	259.2	262.3
	G205	265.3	260.7	267.3	272.8	252.0	265.1
	G206	259.6	240.7	265.9	273.2	251.2	257.7
	G208	247.4	240.0	255.2	262.4	245.2	261.4
	G401	259.3	249.8	263.4	272.8	256.7	264.5
	G402	268.7	265.4	275.8	282.9	272.5	265.7
	G403	271.3	263.2	267.3	273.6	257.4	264.6
	G404	259.5	264.0	272.0	279.2	270.8	265.0
	G405	266.4	265.4	276.4	282.0	272.1	266.6
	G406	269.5	258.4	278.3	284.1	269.9	266.0

Table 11.--K, C, L, and P band scatterometer data

DATE	SITE	BACKSCATTERING COEFFICIENT AT INDICATED DEGREE OF LOOK ANGLE									
		5	10	15	20	25	30	35	40	45	50
		DB									
1979		K BAND									
MAY 1	G402	5.7	-3.4	-5.6	-7.1	-7.7	-9.0	-9.3	-9.2	-10.3	-11.3
	G403	33.2	-0.8	-3.3	-4.8	-5.9	-6.8	-8.2	-8.3	-10.3	-10.8
	G404	11.4	-1.1	-2.5	-4.5	-5.6	-5.5	-7.2	-8.4	-9.0	-9.3
	G405	---	-3.7	-4.4	-6.2	-6.6	-7.5	-7.8	-8.2	-8.6	-9.6
	G406	---	-3.7	-4.4	-6.2	-6.6	-7.5	-7.8	-8.2	-8.6	-9.6
MAY 2	F201	-0.4	-2.2	-2.6	-3.5	-5.4	-6.4	---	---	---	---
	F202	-0.5	-0.9	-2.1	-3.5	-4.2	-4.4	-5.1	-6.0	-5.7	-5.4
	F203	-1.6	-3.6	-4.7	-6.3	-6.8	-6.6	-6.6	-7.5	-7.2	-7.5
	F204	0.6	-3.4	-4.8	-6.3	-6.4	-5.8	-6.9	-7.9	-8.6	-9.4
	F205	4.7	0.1	-3.8	-5.8	-6.5	-7.2	-7.4	-8.8	-8.7	-8.4
	F206	-3.0	-4.8	-4.8	-6.5	-6.4	-6.4	-7.0	-7.2	-7.1	-7.0
	F304	0.8	-2.3	-4.1	-6.3	-8.0	-8.7	-9.6	-10.5	-10.1	-12.1
	F305	0.3	-1.8	-4.6	-6.4	-7.4	-7.8	-8.3	-8.6	-10.3	-11.2
	F306	-1.0	-0.7	-2.4	-4.1	-5.0	-5.3	-6.8	-6.7	-8.1	-8.6
	F307	-1.7	-5.1	-5.9	-7.9	-8.4	-8.3	-9.0	-9.7	-10.7	-12.4
	F308	0.8	-4.8	-6.1	-7.8	-9.4	-8.8	-10.3	-10.5	-11.3	-12.2
	F309	-1.7	-1.9	-2.8	-4.9	-5.0	-7.0	-7.1	-7.2	-8.5	-8.1
	F310	-2.5	-3.7	-4.9	-7.8	-9.1	-9.3	-9.5	-9.9	-10.2	-11.9
	F312	-0.2	-2.0	-3.1	-4.6	-5.2	-7.0	---	---	---	---
	F314	-2.5	-2.4	-4.1	-5.4	-5.8	-6.8	-7.5	-7.9	-8.3	-9.0
MAY 22	F201	-0.6	-2.5	-3.1	-3.4	-4.8	-5.6	-6.2	-5.6	-6.4	---
	F202	-1.1	-2.6	-3.7	-4.1	-5.3	-5.7	-6.5	-6.8	-6.7	-8.6
	F203	-0.3	-3.7	-5.1	-7.2	-6.9	-7.7	-7.8	-8.1	-7.2	-8.1
	F204	-2.2	-4.3	-5.1	-5.9	-6.8	-7.0	-7.7	-8.2	-7.7	-7.8
	F205	0.6	-2.8	-5.1	-6.0	-7.8	-8.3	-8.2	-8.5	-9.7	-9.7
	F206	-3.3	-4.9	-6.0	-6.5	-7.7	-8.3	-8.4	-8.1	-9.3	-9.1
	F304	-0.7	-2.3	-5.1	-6.8	-7.8	-8.8	-9.9	-9.7	-11.1	-11.6
	F305	2.8	-0.6	-3.2	-5.1	-5.8	-6.5	-7.7	-8.9	-9.4	-9.3
	F306	-1.9	-4.7	-6.4	-7.6	-8.4	-8.1	-9.6	-9.5	-9.8	-10.3
	F307	-1.4	-4.0	-6.1	-8.0	-9.0	-10.0	-10.9	-10.9	-12.3	-11.6
	F308	-3.4	-5.4	-7.4	-8.2	-9.2	-8.9	-9.9	-10.1	-10.6	-12.3
	F309	-2.2	-3.3	-4.7	-6.8	-7.1	-7.6	-8.2	-8.7	-9.5	-10.5
	F310	-4.2	-5.7	-6.6	-7.8	-8.9	-9.2	-9.7	-9.0	-10.2	-9.6
	F312	2.2	-1.2	-2.9	-5.2	-5.3	---	---	---	---	---
	F314	-3.1	-3.9	-5.2	-5.8	-6.7	-6.8	-8.0	-8.0	-8.6	-9.9
JUNE 13	F201	-0.3	-3.5	-5.0	-6.2	-6.3	-6.3	-7.4	-7.2	-7.4	-9.3
	F202	-3.1	-4.0	-5.3	-6.9	-7.7	-7.7	-8.4	-6.8	-8.4	-8.7
	F203	-3.3	-3.8	-4.2	-5.5	-5.6	-5.3	-6.5	-6.0	-6.7	-7.1
	F204	0.1	-3.1	-4.3	-5.5	-6.1	-5.5	-6.5	-6.8	-6.1	-7.5
	F205	-3.3	-3.8	-4.9	-5.8	-6.0	-5.8	-6.4	-5.5	-7.1	-8.8
	F206	1.1	-2.9	-5.5	-7.8	-8.0	-8.9	-9.9	-10.3	-9.3	-10.1
	F304	-2.9	-3.6	-4.5	-4.7	-6.2	-7.0	-7.4	-6.9	-7.9	-10.0
	F306	2.7	-2.7	-4.5	-6.2	-6.8	-6.3	-7.1	-6.6	-7.2	-9.3
	F307	-5.1	-5.7	-7.2	-7.7	-8.6	-8.7	-10.7	-9.2	-9.6	-12.7
	F308	-5.1	-7.2	-8.0	-9.1	-8.6	-8.1	-9.5	-9.4	-11.0	-10.8
	F309	-0.5	-1.7	-3.7	-4.7	-6.0	-6.4	-7.1	-7.0	-8.3	-11.3
	F310	-5.4	-6.1	-7.3	-8.1	-8.6	-9.1	-10.3	-9.4	-12.9	-12.8
	F312	-0.5	-1.8	-4.1	-5.6	-6.1	-6.3	-7.8	-7.6	-7.3	-9.6
	F314	-0.2	-2.7	-4.5	-6.3	-6.2	-6.9	-7.2	-8.0	-8.3	-10.5
1978		C BAND									
NOV. 30	F201	---	---	---	-9.2	-10.1	-11.4	-13.0	-13.8	---	---
	F202	---	---	---	-9.7	-10.3	-11.9	-12.8	-12.5	-14.5	-15.7
	F203	---	---	---	-8.2	-9.0	-10.0	-10.9	-12.4	-15.6	-15.7
	F204	---	---	---	-7.1	-8.3	-9.9	-11.5	-13.4	-14.3	-14.6
	F205	---	---	---	-12.9	-13.6	-14.6	-16.1	-17.0	-18.4	-21.1
	F206	---	---	---	-5.7	-8.7	-9.3	-9.9	-12.4	-13.5	-14.4
	F304	---	---	---	-10.3	-10.8	-12.8	-13.7	-14.9	-18.0	-17.9
	F306	---	---	---	-9.0	-11.5	-11.2	-13.7	-14.4	-15.4	-15.8
	F307	---	---	---	-7.6	-7.6	-10.8	-11.1	-12.2	-14.6	-15.9
	F308	---	---	---	-9.2	-10.9	-12.7	-12.9	-15.3	-16.0	-18.5

Table 11.--K, C, L, and P band scatterometer data--Continued

DATE	SITE	BACKSCATTERING COEFFICIENT AT INDICATED DEGREE OF LOOK ANGLE									
		5	10	15	20	25	30	35	40	45	50
		DB									
1978					C BAND						
NOV. 30---	F309	---	---	---	-10.1	-11.2	-12.1	-14.6	-14.8	-18.0	-18.3
	F310	---	---	---	-6.5	-7.8	-11.5	-11.4	-12.1	-14.7	-16.0
	F312	---	---	---	-6.1	-8.7	-10.6	-12.9	-13.7	-14.9	-17.7
	F314	---	---	---	-9.0	-10.4	-10.9	-11.8	-13.4	-15.3	-16.9
1979											
MAY 1-----	G402	---	---	---	-10.5	-10.8	-12.5	-12.4	-13.4	-16.6	-16.2
	G403	---	---	---	-9.8	-11.2	-13.8	-14.8	-15.4	-16.7	-18.8
	G404	---	---	---	-6.6	-7.3	-8.6	-10.4	-11.8	-13.1	-16.1
	G405	---	---	---	-10.1	-9.7	-11.6	-12.9	-13.8	-15.2	-16.0
	G406	---	---	---	-11.0	-11.0	-11.9	-13.0	-12.7	-13.1	-16.7
MAY 2-----	F201	---	---	---	-6.8	-8.0	-9.1	---	---	---	---
	F202	---	---	---	0.4	-4.0	-8.1	-8.7	-10.3	-12.0	-14.7
	F203	---	---	---	-6.6	-8.1	-10.5	-11.6	-10.8	-14.6	-14.0
	F204	---	---	---	-9.7	-9.2	-11.4	-10.8	-12.4	-12.9	-14.7
	F205	---	---	---	-7.5	-10.4	-12.1	-11.9	-13.3	-16.2	-14.5
	F206	---	---	---	-7.8	-8.1	-9.4	-11.8	-10.3	-12.6	-13.2
	F304	---	---	---	-9.0	-9.7	-11.6	-13.2	-13.4	-15.0	-14.5
	F305	---	---	---	-8.0	-10.7	-12.2	-14.0	-14.7	-16.4	-18.9
	F306	---	---	---	-6.0	-7.6	-8.2	-10.3	-11.7	-13.7	-13.1
	F307	---	---	---	-10.1	-10.4	-12.4	-14.7	-13.3	-16.2	-19.2
	F308	---	---	---	-9.2	-11.5	-14.2	-14.0	-15.1	-15.9	-17.6
	F309	---	---	---	-5.9	-6.8	-8.2	-9.7	-9.6	-12.1	-12.3
	F310	---	---	---	-9.8	-10.6	-12.2	-12.8	-14.0	-15.8	-17.2
	F312	---	---	---	-8.2	-8.6	-10.3	---	---	---	---
	F314	---	---	---	-8.2	-9.2	-11.0	-11.7	-12.4	-13.3	-14.7
MAY 22----	F201	---	---	---	-6.4	-7.8	-9.3	-10.3	-11.3	-12.4	---
	F202	---	---	---	-8.0	-8.7	-10.5	-10.7	-11.6	-13.4	-15.1
	F203	---	---	---	-6.3	-7.5	-9.5	-10.1	-12.6	-12.9	-15.4
	F204	---	---	---	-6.9	-7.7	-9.8	-10.7	-11.1	-14.0	-15.6
	F205	---	---	---	-7.8	-8.9	-11.8	-10.5	-11.4	-13.5	-16.0
	F206	---	---	---	-5.6	-7.3	-9.9	-10.5	-11.3	-12.0	-14.0
	F304	---	---	---	-8.7	-9.3	-10.5	-13.2	-13.4	-15.8	-16.6
	F305	---	---	---	-3.9	-5.0	-8.5	-8.2	-11.9	-14.4	-15.2
	F306	---	---	---	-8.5	-9.3	-11.8	-11.3	-12.8	-14.5	-16.1
	F307	---	---	---	-6.0	-8.0	-10.1	-11.5	-14.0	-14.7	-15.7
	F308	---	---	---	-10.0	-11.1	-12.6	-13.4	-14.9	-16.1	-18.3
	F309	---	---	---	-4.9	-8.1	-9.4	-9.5	-11.6	-13.0	-15.3
	F310	---	---	---	-9.9	-10.5	-12.0	-13.2	-15.8	-15.8	-17.2
	F312	---	---	---	-5.0	-6.2	-7.8	---	---	---	---
	F314	---	---	---	-8.8	-8.9	-10.6	-10.5	-11.6	-12.6	-14.3
JUNE 13---	F201	---	---	---	-8.3	-8.5	-10.5	-10.4	-11.8	-13.4	-15.1
	F202	---	---	---	-8.2	-9.1	-9.3	-11.7	-12.1	-14.5	-16.6
	F203	---	---	---	-8.5	-9.0	-10.1	-10.4	-11.6	-11.5	-13.7
	F204	---	---	---	-6.8	-8.2	-10.7	-9.5	-10.2	-12.6	-12.7
	F205	---	---	---	-7.6	-7.7	-9.1	-9.8	-11.1	-10.9	-13.6
	F206	---	---	---	-9.8	-9.7	-11.4	-11.5	-12.5	-14.3	-16.4
	F304	---	---	---	-5.8	-6.2	-8.0	-10.2	-11.1	-12.3	-13.9
	F306	---	---	---	-8.6	-9.8	-11.1	-10.2	-11.7	-13.4	-14.5
	F307	---	---	---	-7.8	-8.6	-10.7	-10.4	-12.5	-14.1	-16.6
	F308	---	---	---	-10.1	-11.6	-13.7	-12.7	-13.6	-16.7	-17.9
	F309	---	---	---	-4.2	-4.6	-6.7	-7.9	-10.0	-12.7	-12.6
	F310	---	---	---	-8.6	-9.7	-11.4	-12.6	-13.1	-15.3	-17.4
	F312	---	---	---	-4.4	-7.1	-8.1	-8.9	-10.7	-12.0	-14.1
	F314	---	---	---	-8.6	-9.6	-10.1	-10.5	-10.8	-12.7	-15.2

Table 11.--K, C, L, and P band scatterometer data--Continued

DATE	SITE	BACKSCATTERING COEFFICIENT AT INDICATED DEGREE OF LOOK ANGLE									
		5	10	15	20	25	30	35	40	45	50
		DB									
1978		L BAND									
NOV. 30	F201	6.1	-4.8	-8.1	-9.7	-11.4	-13.4	-13.5	-15.4	---	---
	F202	-2.8	-10.6	-11.4	-11.8	-13.5	-14.1	-14.1	-16.1	-18.0	-16.3
	F203	4.2	-2.0	-2.5	-2.0	-6.2	-10.2	-10.4	-11.1	-14.2	-13.0
	F204	1.7	-0.5	-1.5	-3.6	-5.9	-11.3	-11.4	-13.8	-13.5	-14.8
	F205	---	-13.1	-15.2	-18.3	-19.3	-19.4	-20.1	-19.3	-22.3	-23.6
	F206	2.9	1.8	-0.8	-4.6	-7.7	-7.8	-8.1	-9.7	-12.3	-12.1
	F304	-1.3	-5.9	-10.2	-10.3	-14.1	-16.6	-15.8	-16.9	-20.3	-20.6
	F306	-4.3	-10.0	-10.6	-9.8	-12.0	-14.8	-13.9	-14.6	-16.3	-16.4
	F307	1.1	-3.7	-5.1	-6.2	-9.7	-11.5	-12.5	-13.2	-15.8	-17.7
	F308	-0.9	-6.9	-8.5	-8.1	-10.2	-11.6	-13.0	-15.2	-16.9	-17.3
	F309	3.5	-5.1	-7.1	-9.3	-10.9	-14.8	-16.1	-19.2	-20.0	-21.5
	F310	5.0	-1.6	-5.8	-8.2	-11.3	-16.0	-15.4	-18.6	-20.4	-20.7
	F312	2.6	-2.2	-5.2	-7.6	-9.8	-10.6	-11.8	-14.3	-14.8	-16.5
	F314	0.2	-4.5	-6.0	-8.7	-9.4	-9.7	-9.0	-11.8	-11.3	-18.1
1979											
MAY 1	G402	4.3	-8.9	-10.9	-9.7	-9.0	-10.0	-10.1	-10.5	-11.1	-12.9
	G403	11.7	-8.8	-10.5	-12.2	-13.1	-13.5	-15.1	-16.0	-15.1	-13.8
	G404	15.6	-3.8	-5.1	-6.8	-7.9	-9.2	-9.2	-9.1	-10.0	-11.8
	G405	-0.2	-5.3	-7.7	-7.5	-7.8	-8.0	-8.1	-10.9	-9.9	-10.1
	G406	15.6	-7.3	-8.0	-8.1	-9.9	-10.4	-10.0	-10.6	-11.0	-10.6
MAY 2	F201	4.1	-8.0	-8.8	-10.5	-10.9	---	---	---	---	---
	F202	0.8	-2.1	0.1	-1.0	-5.3	-7.1	-9.4	-11.5	-13.2	-14.9
	F203	2.9	-0.5	-3.2	-6.6	-7.0	-7.8	-10.8	-14.2	-11.7	-14.6
	F204	4.5	2.2	-3.2	-5.2	-7.8	-9.3	-10.1	-11.4	-11.8	-15.3
	F205	5.4	-1.1	-3.9	-7.9	-9.9	-11.1	-10.2	-12.8	-11.5	-13.0
	F206	2.0	-0.8	-3.6	-5.8	-7.5	-9.2	-11.1	-11.5	-11.4	-13.7
	F304	2.9	-4.3	-7.4	-10.5	-11.7	-13.5	-15.8	-16.1	-17.1	-15.8
	F305	1.9	-2.5	-7.3	-9.4	-11.4	-13.1	-15.1	-15.2	-16.4	-13.1
	F306	0.7	-3.7	-4.0	-4.6	-5.9	-9.5	-8.2	-8.6	-11.4	-10.4
	F307	0.1	-4.6	-7.9	-12.4	-13.6	-13.7	-15.3	-17.0	-18.4	-20.5
	F308	0.7	-2.3	-6.5	-9.8	-11.3	-13.5	-14.3	-18.1	-15.8	-15.7
	F309	0.3	-1.9	-3.4	-4.3	-6.5	-5.8	-5.8	-8.8	-8.5	-9.7
	F310	3.0	-3.3	-4.7	-9.7	-13.2	-14.8	-16.0	-16.2	-18.1	-20.1
	F312	1.9	-6.4	-7.8	-8.8	---	---	---	---	---	---
	F314	-3.8	-6.4	-8.6	-9.0	-9.6	-10.8	-9.9	-11.6	-16.1	-16.4
MAY 22	F201	-5.7	-11.2	-11.3	-13.5	-12.2	-13.9	-13.7	-15.1	-15.1	---
	F202	-3.6	-10.6	-11.4	-11.9	-13.6	-14.8	-14.4	-15.4	-16.8	-17.3
	F203	6.4	-1.3	-2.5	-3.9	-7.6	-11.2	-11.6	-14.7	-16.6	-18.6
	F204	0.9	-2.7	-3.1	-3.7	-7.0	-10.4	-11.9	-12.6	-14.9	-15.7
	F205	3.0	0.5	-3.8	-4.5	-7.3	-9.3	-12.1	-14.4	-16.7	-15.8
	F206	1.5	1.3	0.2	-4.3	-9.0	-10.7	-11.7	-13.0	-13.7	-14.3
	F304	-2.7	-6.4	-8.6	-10.3	-13.0	-15.8	-14.5	-15.7	-18.6	-17.8
	F305	---	-7.2	-8.3	-9.7	-11.5	-13.2	-13.4	-13.6	-15.2	-15.3
	F306	-1.6	-5.7	-9.3	-11.1	-13.9	-12.5	-13.2	-16.2	-16.4	-17.2
	F307	0.2	-3.9	-7.4	-8.6	-8.6	-10.0	-12.8	-14.3	-22.0	-20.2
	F308	-7.6	-12.3	-13.6	-16.8	-18.4	-18.7	-19.3	-21.3	-22.5	-23.7
	F309	-0.3	-6.1	-7.7	-9.7	-11.5	-13.5	-16.6	-15.1	-16.1	-20.9
	F310	-1.4	-6.9	-10.4	-12.7	-17.1	-18.2	-19.7	-21.8	-22.0	-23.0
	F312	1.6	-2.7	-5.9	-6.5	-8.0	---	---	---	---	---
	F314	-4.5	-10.7	-11.7	-12.7	-12.3	-12.3	-13.1	-14.0	-16.5	-17.4
JUNE 13	F201	-4.6	-8.5	-10.8	-10.4	-13.1	-13.6	-14.0	-14.6	-15.3	-14.4
	F202	1.8	-1.9	-1.4	-6.1	-9.4	-10.4	-10.8	-14.2	-12.5	-15.3
	F203	-0.8	-1.0	-2.4	-4.5	-8.5	-10.8	-11.6	-11.4	-13.6	-12.8
	F204	0.5	-2.6	-3.9	-5.8	-9.5	-9.6	-10.9	-12.6	-13.2	-14.8
	F205	2.3	-0.8	-2.3	-6.5	-9.6	-10.7	-10.9	-11.3	-13.9	-12.3
	F206	-0.1	-4.8	-7.5	-8.4	-11.1	-11.1	-12.0	-13.5	-15.1	-13.6
	F304	-2.6	-7.6	-7.1	-7.5	-7.5	-9.4	-8.8	-10.5	-13.5	-12.3
	F306	-1.9	-7.1	-8.5	-10.4	-11.4	-12.0	-11.9	-14.8	-13.9	-14.9
	F307	2.1	-4.7	-7.2	-9.4	-12.1	-12.8	-13.4	-13.7	-17.2	-18.7
	F308	1.2	-5.9	-9.5	-11.8	-12.9	-12.8	-13.0	-14.6	-17.5	-21.3
	F309	-0.1	-2.8	-4.9	-4.6	-5.6	-6.0	-7.5	-7.9	-9.2	-7.6
	F310	-0.3	-7.1	-10.7	-12.4	-15.0	-16.8	-18.0	-20.4	-21.7	-22.3
	F312	1.3	-4.2	-5.4	-5.9	-6.9	-8.2	-8.0	-8.2	-9.3	-11.2
	F314	-4.2	-8.1	-9.2	-9.3	-10.0	-7.6	-9.4	-14.4	-11.4	-14.2

Table 11.--K, C, L, and P band scatterometer data--Continued

DATE	SITE	BACKSCATTERING COEFFICIENT AT INDICATED DEGREE OF LOOK ANGLE									
		5	10	15	20	25	30	35	40	45	50
		DB									
1978		P BAND									
NOV. 30	F201	-8.9	-20.8	-26.9	-23.5	-23.5	---	---	---	---	---
	F202	-12.3	-19.9	-24.1	-25.2	-26.4	-26.3	-27.6	-25.8	-27.7	-27.4
	F203	-15.3	-15.7	-17.6	-18.1	-19.1	-20.8	-21.2	-22.3	-22.6	-25.7
	F204	-14.2	-12.2	-17.0	-21.3	-22.4	-19.2	-20.9	-23.0	-23.4	-24.3
	F205	---	-40.8	-42.4	-44.8	-43.2	-42.8	-44.3	-45.1	-46.2	-46.4
	F206	-12.8	-13.4	-16.8	-20.9	-20.6	-22.0	-23.9	-24.2	-24.0	-25.0
	F304	-14.9	-23.2	-25.2	-24.6	-28.3	-24.1	-27.8	-28.0	-27.4	-28.6
	F306	-9.3	-20.4	-21.5	-22.7	-20.7	-20.0	-22.6	-22.2	-23.3	-22.0
	F307	-3.7	-18.6	-24.7	-22.4	-24.6	-24.3	-24.5	-21.3	-29.5	-23.7
	F308	-9.0	-22.0	-25.7	-25.8	-24.0	-22.0	-26.0	-22.2	-25.7	-23.9
	F309	-3.0	-17.0	-20.8	-20.5	-18.4	-17.0	-18.3	-18.6	-18.8	-18.6
	F310	-16.5	-19.2	-23.0	-23.2	-22.6	-22.3	-28.7	-28.1	-30.2	-28.7
	F312	-4.4	-19.6	-21.7	-21.0	-21.5	-19.9	-19.1	-20.0	-21.4	-22.7
	F314	-7.7	-21.6	-22.7	-21.0	-20.8	-20.6	-21.1	-22.5	-23.2	-23.6
1979											
MAY 1	G402	-13.8	-23.0	-23.4	-21.8	-22.3	-21.3	-22.0	-21.6	-21.4	-22.1
	G403	-3.0	-20.6	-25.2	-26.9	-25.3	-19.1	-24.1	-23.7	-20.9	-25.2
	G404	-6.2	-18.7	-19.6	-18.5	-18.7	-18.3	-18.2	-20.6	-20.1	-21.9
	G405	-10.4	-16.7	-21.3	-19.5	-21.0	-19.5	-20.2	-20.7	-20.7	-20.5
	G406	-16.6	-24.3	-25.4	-26.7	-24.2	-23.9	-22.9	-24.3	-22.4	-21.8
MAY 2	F201	---	-28.4	-29.4	-28.5	-28.9	-26.7	-29.1	-31.1	-27.9	-25.0
	F202	-13.1	-14.7	-17.5	-17.4	-18.0	-18.0	-23.2	-24.3	-26.4	-24.4
	F203	-12.1	-14.0	-16.9	-17.5	-20.1	-20.0	-23.3	-24.9	-25.9	-26.9
	F204	-15.7	-15.1	-15.7	-20.5	-23.8	-23.6	-24.9	-24.5	-25.7	-25.8
	F205	-13.7	-16.2	-19.1	-22.2	-24.6	-26.1	-27.0	-27.1	-28.0	-25.0
	F206	-16.4	-19.3	-21.8	-24.6	-25.3	-25.9	-27.4	-26.2	-25.9	-24.7
	F304	-4.9	-19.6	-24.2	-21.7	-25.5	-24.8	-24.1	-22.5	-20.8	-21.3
	F305	-7.1	-20.8	-26.8	-26.7	-25.0	-25.6	-24.5	-25.5	-23.0	-24.0
	F306	-13.8	-22.7	-25.1	-21.0	-21.4	-21.8	-25.7	-25.6	-23.9	-25.6
	F307	-12.7	-26.7	-27.8	-28.7	-30.9	-31.8	-32.1	-33.8	-32.8	-31.0
	F308	-8.8	-26.2	-28.2	-33.0	-33.2	-32.8	-33.6	-32.9	-33.4	-33.1
	F309	-20.7	-22.1	-22.6	-24.0	-27.9	-25.9	-24.8	-25.3	-25.5	-29.1
	F310	-14.1	-22.8	-27.4	-24.5	-24.1	-23.6	-26.3	-21.1	-22.2	-22.6
	F312	---	-27.6	-32.8	-34.6	-35.7	-34.9	-35.4	-29.2	-30.4	-32.6
	F314	-13.8	-19.5	-21.5	-21.1	-20.0	-22.2	-21.6	-20.8	-23.3	-22.2
MAY 22	F201	-16.4	-30.0	-32.1	-30.5	-30.4	---	---	---	---	---
	F202	-16.9	-25.8	-28.7	-29.7	-29.4	-28.1	-29.6	-27.5	-27.1	-27.5
	F203	-17.7	-23.4	-25.3	-23.4	-22.0	-22.4	-28.4	-27.5	-28.4	-28.1
	F204	-18.8	-23.9	-24.9	-27.9	-29.7	-28.8	-28.0	-25.7	-27.3	-28.2
	F205	-19.5	-26.1	-29.4	-28.0	-29.2	-30.1	-28.7	-28.2	-29.2	-26.8
	F206	-18.7	-25.5	-27.9	-27.4	-28.2	-26.9	-28.8	-25.7	-27.1	-26.3
	F304	-15.0	-27.3	-30.8	-29.8	-30.8	-31.5	-29.9	-29.2	-30.4	-27.0
	F305	-13.8	-28.4	-28.0	-26.6	-27.5	-29.0	-28.8	-26.7	-28.6	-28.5
	F306	-16.2	-27.2	-30.6	-30.2	-30.6	-28.9	-28.1	-28.3	-28.6	-28.1
	F307	-18.6	-28.1	-31.3	-30.2	-32.0	-30.0	-30.0	-23.3	-27.9	-28.7
	F308	-13.8	-26.0	-30.7	-34.9	-35.9	-30.7	-26.3	-28.0	-29.8	-29.8
	F309	-15.7	-27.3	-29.7	-31.5	-32.3	-30.5	-31.1	-33.4	-32.5	-33.3
	F310	-13.9	-26.4	-31.0	-29.9	-28.8	-27.6	-27.3	-26.1	-26.2	-24.2
	F312	-16.9	-24.9	---	---	---	---	---	---	---	---
	F314	-13.2	-24.6	-26.4	-25.3	-26.8	-26.3	-27.3	-24.5	-27.8	-27.7
JUNE 13	F201	-12.7	-18.6	-21.8	-20.8	-17.5	-21.3	-24.8	-23.9	-28.5	-27.1
	F202	-14.5	-17.7	-20.6	-19.8	-20.6	-22.0	-23.0	-26.1	-26.1	-28.0
	F203	-18.0	-16.7	-18.2	-22.1	-26.4	-23.9	-25.6	-24.1	-28.3	-26.7
	F204	-16.9	-17.8	-23.5	-24.1	-25.2	-24.3	-24.6	-24.2	-25.0	-26.0
	F205	-16.6	-18.4	-19.8	-23.9	-24.9	-23.9	-27.9	-30.2	-28.2	-26.3
	F206	-13.6	-27.3	-31.5	-31.5	-30.7	-28.8	-30.5	-28.5	-28.1	---
	F304	-14.3	-21.7	-25.3	-24.9	-23.7	-22.7	-24.1	-22.1	-26.5	-23.2
	F305	-11.0	-25.0	-26.5	-25.6	-26.3	-25.8	-26.4	-24.9	-25.0	-24.3
	F307	-7.5	-24.4	-28.7	-29.5	-29.4	-28.8	-29.4	-27.8	-29.9	-27.2
	F308	-7.1	-19.3	-25.4	-25.4	-24.8	-21.8	-25.2	-22.6	-24.2	-27.8
	F309	-13.3	-25.1	-24.6	-23.0	-26.5	-22.8	-24.9	-25.6	-26.9	-25.6
	F310	-9.6	-23.7	-26.9	-24.9	-24.0	-22.4	-28.2	-25.3	-25.6	-27.2
	F312	-12.6	-22.8	-23.5	-21.8	-22.3	-19.9	-22.0	-21.0	-20.5	-19.6
	F314	-1.6	-19.2	-24.4	-22.5	-21.2	-19.2	-19.7	-22.9	-22.7	-23.5

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APPENDIX

The data in table 12 are from several reports. Only selected properties for the shallowest surface layer are included. Most of the variables are self-explanatory. The Brooks and Corey parameters are utilized in an infiltration method. λ is a dimensionless pore-size distribution index, Ψ_B is the bubbling pressure in centimeters, and θ_r is the residual soil water content in cubic centimeters per cubic centimeter. Additional details can be found in Brakensiek et al. (1981).

Table 12.--Florida and Georgia soil properties

Soil series	Texture[1]	Depth	Particle size distribution: Sand	Silt	Clay	Bulk density	Saturated conductivity	Porosity	Organic content	Volumetric moisture content at suction: 0.33 bar	15 bar	Brooks Corey parameters: λ	ψ_B	θ_r	Reference
		Cm	Percent	Percent	Percent	G per cm3	Cm per hr	Percent	Percent	Percent	Percent				
Alapaha------	Sa----	10	87.3	8.9	3.8	1.52	---	42.6	---	18.04	7.54	0.709	73.375	0.075	McCreery (1966).
	LSa---	7	---	---	---	1.40	---	47.2	---	14.59	6.23	.613	24.875	.051	Holtan et al. (1968).
	LSa---	5	---	---	---	1.45	---	45.3	---	28.26	14.24	.476	39.875	.093	Do.
Chobee-------	Sa----	13	97.6	1.6	.8	1.34	152.00	49.4	0.9	---	2.10	.722	10.767	.021	Do.
	SaL---	15	58.5	25.2	16.3	.89	28.90	66.4	7.4	---	15.00	.196	24.250	.00002	Do.
Fuquay-------	LSa---	15	88.2	7.8	4.0	1.50	55.20	43.4	1.0	6.70	3.50	.737	9.098	.034	Carlisle et al. (1978).
	LSa---	10	77.7	17.1	5.2	1.39	15.90	47.5	2.9	14.10	6.30	.350	3.469	.0368	Do.
	LSa---	20	84.7	11.0	4.3	1.45	---	45.2	.0	10.06	3.74	1.350	77.961	.037	McCreery (1966).
	LSa---	15	85.4	8.8	5.8	1.52	---	42.6	.0	14.58	4.70	.215	1.791	.00006	Do.
	Sa----	25	88.8	8.6	2.6	1.58	---	40.3	.0	7.57	2.13	1.100	58.063	.021	Do.
	LSa---	10	---	---	---	1.66	---	37.4	---	7.70	1.67	.334	2.783	.000	Do.
	LSa---	9	---	---	---	---	---	---	---	9.10	5.49	.816	31.063	.053	Do.
Immokalee----	Sa----	13	96.2	2.6	1.2	1.24	139.00	53.2	1.4	---	2.80	.280	.718	.000	Do.
	Sa----	9	---	---	---	1.56	---	41.1	---	7.56	3.58	1.085	36.625	.033	Do.
Lakeland-----	LFSa--	13	82.9	11.6	5.5	1.40	37.08	47.1	.0	---	2.94	.886	44.031	.026	Lund et al. (1960).
	Sa----	10	89.0	8.0	3.0	1.33	---	49.8	.0	---	3.94	.400	3.687	.020	Long et al. (1963).
	Sa----	13	95.6	.3	4.1	1.30	45.97	50.9	.0	---	2.99	.641	3.187	.026	Lund et al. (1961).
	Sa----	10	89.0	8.0	3.0	1.33	.91	49.8	2.6	---	3.94	.553	8.267	.035	Long et al. (1969).
	Sa----	10	84.0	9.0	7.0	1.18	1.52	55.4	2.9	---	4.87	.705	11.562	.047	Do.
	LSa---	8	94.0	4.0	2.0	1.29	.46	51.3	1.3	---	2.22	.825	7.105	.022	Do.
	Sa----	6	---	---	---	---	---	---	---	8.58	1.19	.871	49.875	.011	Do.
	Sa----	10	---	---	---	---	---	---	---	3.11	.68	1.081	33.422	.006	Do.
	Sa----	6	---	---	---	---	---	---	---	7.21	1.87	.269	1.188	.000	Do.
Leefield-----	LSa---	6	---	---	---	1.47	---	44.5	---	16.06	7.55	.300	2.781	.038	Do.
	LSa---	10	---	---	---	1.44	---	45.7	---	10.25	6.63	1.292	51.938	.066	Do.
Myakka-------	FSa---	13	93.3	4.5	2.2	1.47	15.80	44.5	3.4	11.40	9.80	.940	23.898	.087	Carlisle et al. (1978).
	FSa---	10	92.9	3.3	3.8	1.15	46.00	56.6	3.0	18.10	6.40	.242	2.583	.000	Do.
	FSa---	18	88.3	8.5	3.2	1.27	72.30	52.0	6.8	12.60	5.40	.391	.036	2.631	Do.
	Sa----	10	96.6	2.2	1.2	1.39	17.10	47.5	1.7	10.60	4.20	.335	1.031	.024	Do.
	Sa----	13	92.2	5.7	2.1	1.27	48.90	52.0	3.1	10.90	4.30	.431	3.500	.031	Do.
Placid-------	Sa----	25	88.7	8.0	3.3	1.11	17.70	58.1	11.2	37.90	9.50	.227	31.593	.000	Do.
Rains--------	LFSa--	25	77.0	19.0	4.0	1.47	---	44.5	.8	---	3.38	.745	14.922	.033	Do.
	FSaL--	18	76.0	16.0	8.0	1.47	.15	44.5	.9	---	4.95	.994	61.688	.049	Do.
	FSaL--	25	74.0	20.0	6.0	1.31	1.52	50.5	1.0	---	3.20	.602	20.535	.022	Do.
	FSaL--	5	---	---	---	1.63	---	38.5	---	12.75	3.65	.498	34.203	.036	Do.
Tifton-------	LSa---	25	81.2	9.9	8.6	1.59	---	40.0	.0	11.29	5.07	.258	1.986	.016	McCreery (1966).
	LSa---	13	85.5	9.7	4.8	1.48	---	44.1	.0	12.66	2.51	.700	52.984	.024	Do.
	LSa---	20	85.6	5.6	8.8	1.81	---	31.6	.0	10.32	4.83	1.199	89.219	.048	Do.
	SaL---	15	89.8	4.6	5.6	1.77	---	33.2	.0	9.94	9.46	.799	5.875	.092	Do.
	SaL---	20	68.8	14.9	16.3	1.61	4.90	39.2	1.4	18.20	10.50	.319	10.125	.074	Carlisle et al. (1978).
Wabasso------	Sa----	18	92.6	4.3	3.1	1.44	16.80	45.6	3.4	9.20	3.60	.580	9.660	.030	Do.

[1] FSa = fine sand; FSaL = fine sandy loam; LFSa = loamy fine sand; LSa = loamy sand; Sa = sand; SaL = sandy loam.

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